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ASTRONOMY.

On the Dispersion of Heat and Forces capable of producing the Heat and Light and all the Resultant Phenomena in the Solar System.

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If we accept the nebular hypothesis as true, as most of the astronomers of the present day, I believe, do,—and nothing accounts so well for all the known phenomena of the solar system,—we must believe that the heat of the sun and of all the planets and their satellites is gradually being dissipated, and that ultimately, unless some unknown source of heat is supplying the waste, they will become cold, dead bodies, inactive so far as heat and its attendant phenomena affect them.

It is true that Mr. Proctor, in a recent address,* claims that our world has been partly, at least, built up by accretion, but there is no sufficient evidence to sustain this position. There is nothing to prove that our earth has been increased perceptibly by this cause. If we admit that it has been so increased, we must assume that there was formerly a much greater in-drawing of extrinsic matter than now, an assumption we have no sufficient reason to indulge. We have as much reason to believe that the fall of me-

*Address before the Kansas City Academy of Science 1876.

teors is greater now than formerly, as to believe that it was greater formerly than now. But Mr. Proctor does not deny, on the contrary he claims, that the nebular hypothesis is true in part. If true in part it may be true in all, and this he admits. If we consider our own planet, we find evidence deeply interwoven in its entire structure which clearly unfolds a past history widely different from its present condition. There is evidence of a former far greater degree of heat than we experience now; heat so intense, indeed, that after passing a probable stage in which all of our metals and solid rocks were held in incandescent vapor, a stage was reached in which they were still held in a vast, glowing, molten mass so intensely heated as to drive off in a gaseous vapor all of the waters now collected in our vast oceans, and to hold them suspended in a cloud envelope of great thickness. From this condition the earth has gradually cooled down, by a slow dispersion of its heat, to its present condition. Judging from what has taken place in the past, we have reason to believe that this dispersion of heat will continue until the entire heat force of the earth is exhausted; until the earth becomes a cold, dead body, destitute of life, as we now find its attendant satellite. The moon is believed to be now destitute of heat, destitute of life, and destitute of an atmosphere and of water upon its surface; its face pitted over with deep valleys, environed by high mountains; the mountain shadows so vast as to be seen with the naked eye. This manifest display of former volcanic action gives unmistakeable evidence of immense past forces caused by internal heat; forces which long since have ceased. The atmosphere and water, which no doubt prevailed on the moon's surface during its active stage, have disappeared, probably swallowed up in some other form in its interior.

If we consider the inner planets, those nearer the sun than the earth, and conforming nearest to it in size, we find their present condition very similar to that of the earth. If we look to the larger outer planets, especially to Jupiter and Saturn, we find them still in a state of glowing heat, with the water, which will be ultimately collected together upon their surfaces in vast oceans, now held in vapor, enveloping them in vast cloud masses. The great ruler of the day, the mighty sun, whose mass is so superior to all of its attendant planets, and to which it has given birth, is still far more intensely heated than any of them. His heat is so intense, indeed, as to drive off his lighter metals, such as iron, nickel, sodium, &c., in vapor, as our water is suspended in vapor in the earth's atmosphere. Such is believed to be the present condition of our solar system by those most distinguished in physics.

If the sun and planets have a common origin, the degree of heat intensity must have been at one time homogeneous, and the difference now prevailing the result of separation and consequent difference in mass, which destroyed the former homogeneity by changed condition or relation. It is well known that a small body, heated to the same degree, loses its heat much sooner than a larger one.

If the heat of the solar system be motion, undulation, or vibration, and is continually being diminished, it may be assumed to be but transitory, and must have had a beginning, as there will be a time when it will entirely cease in its near relation to our solar system. There must, too, have been a cause adequate to give rise to the motion, undulation, vibration, or heat. Now, what force could give rise to the vast volume of heat contained in the whole mass of matter of the solar system, while suspended in incandescent vapor, but the ultimate force of the entire mass of matter itself drawn in and hurled together by its own unresisted attraction? Any less power would be inadequate to its production. That motion may be converted into heat, and heat into motion, we see continually and familiarly illustrated. Take a piece of wire between your thumb and finger, bend it rapidly back and forth, and heat too great for the hand to endure will soon be produced. Strike rapidly, with a hammer, on a bar of iron—heat is the result. Take a bar of steel with a blunt end, apply the end to a rapidly-revolving emery wheel, take hold of the middle of the bar with one hand, and with the other grasp the opposite end—the hand in the center will experience no heat, while the end grasped by the other hand will soon become so hot that the hand cannot endure it. This is caused by the obstruction offered by the hand to the heat waves, set in motion by the emery-wheel. A thermometer placed at the end of the bar will not indicate a greater degree of heat, because it offers no resistance to the heat waves. A ball discharged from a cannon, coming in contact with a stationary solid body, or with another body moving rapidly in an opposite direction, becomes greatly heated, as, also, would the body in motion coming in contact with it. Now, the heat so generated, after its cause has ceased, itself ceases, being gradually dissipated, and the heated substance becomes cold. The dispersion is in proportion to the mass of the body heated and the amount of resistance offered to the vibration or heat waves. A small body will lose its heat sooner than a large one, other conditions being equal.

Heat, then, may have its origin in motion or arrested motion, and when so originated is not permanent, but passes gradually away. The largest-sized cannon-ball, heated to redness, soon loses its heat and becomes cold, when the cause of its heat ceases.

Suppose two cold balls or globes a mile in diameter, composed of all the elements of which the solar system is made up, moving in opposite directions, could be thrown together, each moving with a velocity of a hundred miles per second, the heat imparted to them by the arrested motion—which would be in proportion to the velocity with which they came in contact—would be sufficient to drive off the matter of which they were composed in an incandescent gaseous condition. If they were removed beyond the influence of any attraction greater than their own, they would expand in consequence of the heat generated by the impact, until the expansive force of the heat was overcome by the central attractive force of the mass. When the catastrophe which generated the heat was over, the dispersion

of the heat generated would begin, and would continue until the entire heat force was exhausted, and the mass become cold. During this gradual dispersion of heat, the mass of matter would gradually shrink. Now, suppose this mass, while so intensely heated and expanded, should be revolving on its own axis, by which a force or tendency to throw off was established at its outer surface, it is probable that the central indrawing attractive force would be overcome on the extreme outer surface by this counter force, or tendency to throw off, leaving rings at the outer surface. These rings would have themselves a center of attraction peculiar to themselves, and would be ultimately drawn together around a common center. Now, suppose these bodies thrown off to vary in mass, the smaller ones would lose their heat in less time than the larger ones, and we should find the different parts of the original mass so separated varying in intensity of heat, and this variation or difference in degree would continue until the dispersion of heat from all of them was complete.

Heat, then, may be considered an accident of matter, which may be called into existence and dispersed by certain of its phases. Light dependent on heat, and perhaps also electricity may be placed in the same category. But you may perceive that in our supposed globes or balls, while heat, light, and perhaps electricity, are but evanescent, there is one force which is constant—a force "without variation or shadow of change"—a force which says to the expansion of heat, "Thus far shalt thou go, and no farther." I mean the great force of attraction, which is as silent, as constant, as durable, as time itself. Heat, light, life—all are the direct or indirect results of this silent force. The genial heat and light, which give life and beauty to the vast surface of our earth, are but the unexpended remnant of the heat and light called into being by a former collision of the sun and his attendant planets, caused by the ever-present, unrelenting force of attraction. We will suppose the heat of the solar system, as in case of our balls or globes, to be entirely dispersed, and the whole mass of matter of which the solar system is composed, like them, hurled together, the heat generated by the impact would be so great as to throw off its entire matter in an incandescent gaseous or nebulous condition. But this would not destroy, effect, or change the attractive force. On the contrary, the expansive force of the heat thus generated would be, within definite limits, overcome by the central attractive force. A dispersion of heat and a shrinkage or indrawing of the matter would begin. Rings would be formed by the opposing centripetal and centrifugal forces; these rings would be each drawn to a common center, and a system of worlds similar to those of our present solar system would be the result. How often it has undergone these changes is beyond the power of the imagination to conceive. Like the fabled Phœnix, our solar system, with all its manifold, varied and mysterious life, rises into new life and vigor from the ashes of its own ruin. While we find inherent in matter forces sufficiently potent to generate all of the heat and light of the solar system, with all their resultant phe-

nomena,—forces capable of "rolling the heavens and earth together as a great scroll," and "melting them in fervent heat,"—and that such forces have been exerted and may be exerted again, I may safely assure my friends that they are in no immediate danger from this cause, and that this generation *will* "pass away before these things shall be."

The cause of attraction is not known, but may yet be found in magnetism. The motions of the heavenly bodies, as well as attraction, may possibly be found in the two-fold forces of electricity and its kindred mystery, magnetism. But I cannot pursue this branch of the subject now without the risk of wearying your patience, and shall have to defer it to some future occasion when time and opportunity offers.

MOONLIGHT.*

BY RICHARD A. PROCTOR, B. A.

The light of the moon and the changes of the moon were probably the first phenomena which led men to study the motions of the heavenly bodies. In our times, when most men live where artificial illumination is used at night, we can scarcely appreciate the full value of moonlight to men who cannot obtain artificial light. Especially must moonlight have been valuable to the class of men among whom, according to all traditions, the first astronomers appeared. The tiller of the soil might fare tolerably well without artificial light, though even he—as indeed the familiar designation of the harvest moon shows us—finds especial value, sometimes, in moonlight. But to the shepherd moonlight and its changes must have been of extreme importance as he watched his flocks and herds by night. We can understand how carefully he would note the change from the new moon to the time when, throughout the whole night, or at least of the darkest hours, the full moon illuminated the hills and valleys over which his watch extended, and thence to the time when the sickle of the fast-waning moon shone but a short time before the rising of the sun. To him, naturally, the lunar month, and its subdivision, the week, would be the chief measure of time. He would observe—or rather he could not help observing—the passage of the moon around the zodiacal band, some twenty moon breadths wide, which is the lunar roadway among the stars. These would be the first purely astronomical observations made by man; so that we learn without surprise, that before the present division of the zodiac was adopted, the old Chaldean astronomers (as well as the Indian, Persian, Egyptian and Chinese astronomers, who still follow the practice), divided the zodiac into 28 lunar mansions, each mansion corresponding nearly to one day's motion of the moon among the stars.

It is easy to understand how the first rough observations of moonlight

"* The Day of Rest."

and its changes taught men the true nature of the moon, as an opaque globe circling round the earth, and borrowing her light from the sun. They perceived, first, that the moon was only full when she was opposite the sun, shining at her highest in the south at midnight when the sun was at his lowest beneath the northern horizon. Before the time of full moon, they saw that more or less of the moon's disk was illuminated as he was nearer or farther from the position opposite the sun, the illuminated side being towards the west—that is, towards the sun; while after full moon the same law was perceived in the amount of light, the illuminated side being still towards the sun, that is, towards the east. They could not fail to observe the horned moon sometimes in the day time, with her horns turned directly from the sun, and showing as plainly, by her aspect, whence her light was derived, as does any terrestrial ball lit up either by a lamp or by the sun.

The explanation they gave was the explanation still given by astronomers. Let us briefly consider it. In doing so I propose to modify the ordinary text-book illustration which has always seemed to me ingeniously calculated (with its double set of diversely illuminated moons around the earth) to make a simple subject obscure.

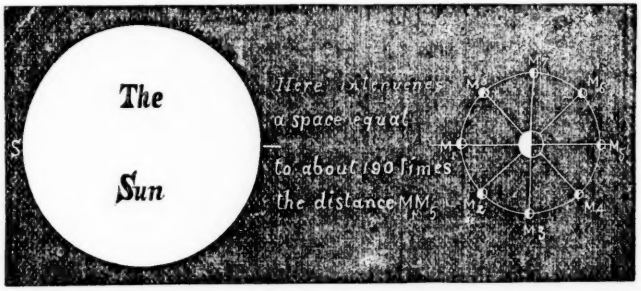

FIG. 1.

In Fig. 1, let E represent the earth one half in darkness, the other half illuminated by the rays of the sun, S, which should be supposed placed at a much greater distance to the left, in fact about five yards away from E. To preserve the right proportions, also, the sun ought to be much smaller and the earth a mere point. I mention this to prevent the reader from adopting erroneous ideas as to the size of these bodies. In reality it is quite impossible to show, in such figures, the true proportions of the heavenly bodies and their distances. Next let M, M^1, M^2, M^3, etc., represent the moon in different portions along the circuit around the earth at E.

Now, it is clear that when the moon is at M^1, her illuminated face is turned from the earth, E. She, therefore, cannot be seen, and accordingly, in Fig. 2, she is presented as a black disk at 1 to correspond with her invisibility when she is at M^1. She passes on to M^2, and now from E a part of her illuminated half can be seen towards the sun, which would be towards the right if we can imagine an eye at E looking towards M^2. Her

appearance then is shown at 2, Fig. 2. In any intermediate portion between M and M^2, the sickle of light is visible but narrower. We see also that all

1 2 3 4 5 6 7 8 9

FIG. 2.

this time the moon's place on the sky cannot be far from the sun's place, for the line from E to M^2 is not greatly inclined to the line from E to S. When the moon has got around to M^3, the observer on the earth sees as much of the dark half as of the bright half of the moon, the bright half being seen, of course, toward the sun. Thus the moon appears at 3, Fig. 2. Again as to position, the moon is now a quarter of a circuit of the heavens from the sun, for the line from E to M^3 is square to the line from E to S. We see similarly that when at M^4 the moon appears as shown at 4, Fig. 2, for now the observer at E sees as small a part of the moon's dark side as he had seen of her bright side when she was at M^2. When she is at M^5, the observer at E sees her bright face only, the dark face being turned directly from him. She, therefore, appears as at 5, Fig. 2. Also being now exactly opposite the sun, as we see from Fig. 1, she is at her highest when the sun is at his lowest, or midnight; and, at this time, rules the night as the sun rules the day.* As the moon passes on to M^6, a portion of her dark half comes into view, the bright side being now towards the left, as we look at M^5 from E, Fig. 1. Her appearance, therefore, is as shown at 5. When at M^7 she is seen at 7, half bright and half dark, as when she was at M^3, but with the halves interchanged. At M^8 she appears as at 8, and, lastly, at M^1 she is again undiscernible.

The ancient Chaldæan astronomers could have little doubt as to the validity of this explanation. In fact, while it is the explanation obviously suggested by observed facts, one cannot see how any other could have occurred to them.

But if they had had any doubts for a while, the occurrence of eclipses would soon have removed those doubts. They must early have noticed that at times the full moon became first partly obscured, then either wholly disappeared or changed in color to a deep coppery red, and after a while

* It has been thought by some that, in the beginning, the moon was always opposite the sun, thus always ruling the night. Milton thus understood the account given in the first book of Genesis. For he says:

Less bright the morn
But opposite in levell'd west was set
His mirror, with full force, borrowing her light
From him; for other light she needed none
In that aspect; and still that distance keeps
Till night, then in the east her turn she shines
Revolv'd on Heav'n's great axle.

It was only as a consequence of Adam's transgression that he conceives the angels sought to punish the human race by altering the movements of the celestial bodies:

To the blank moon
Her office they prescribe—

It is hardly necessary to say, perhaps, that this interpretation is not scientifically admissible.

reappeared. Sometimes the darkening was less complete, so that at the time of greatest darkness a portion of the moon seemed eaten out, though not by a well-defined or black shadow. These phenomena, they would find, only at the time of full moon. And if they were closely observant, they would find that these eclipses of the moon only occurred when the full moon was on or near the great circle round the stellar heavens, which they had learned to be the sun's track. They could hardly fail to infer that these darkenings of the moon were caused by the earth's shadow, near which the moon must always pass when she is full, and through which she must sometimes pass more or less fully; in fact, whenever, at the time of full, she is on or near the plane in which the earth travels round the sun. Solar eclipses would probably be observed later. For though a total eclipse of the sun is a much more striking phenomenon than a total eclipse of the moon, yet the latter are far more common. A partial eclipse of the sun may readily pass unnoticed, unless the sun's rays are so mitigated by haze or mist that it is possible to look at his disk without pain. Whenever solar eclipses came to be noted, and we know from the Chaldæan discovery of the great eclipse period, called the *Sgros*, that they were observed at least two thousand years before the Christian era, the fact that the moon is an opaque body circling round the earth, and much nearer to the earth than the sun is, must be regarded as demonstrated. Not only would eclipses of the sun be observed to occur only when the moon was passing between the earth and the sun, but in an eclipse of the sun, whether total or partial, the round black body cutting off the sun's light wholly or partially would be seen to have the familiar dimensions of the lunar orb.

Leaving solar and lunar eclipses for description, perhaps, on another occasion, I will now proceed to consider a peculiarity of moonlight which must very early have attracted attention—I mean the phenomenon called the harvest moon.

The moon circuits the heavens in a path but slightly inclined to that of the sun, called the ecliptic, and for our present purpose we may speak of the moon as traveling in the ecliptic. Now we know that during the winter half of the year the sun is south of the equator: the circle of the heavenly sphere which passes through the east and west horizon, and has its plane square to the polar axis of the heavens. During the other or summer half of the year he is north of the equator. In the former case the sun is above the horizon less than half the twenty-four hours, day being so much the shorter as the sun is farther south of the equator; whereas in the latter case the sun is above the horizon more than twelve hours, day being so much the longer as the sun is farther north of the equator. Precisely similar changes affect the moon, only, instead of taking place in a year (the time in which the sun circuits the stellar heavens), they occur in what is called a sidereal month, the time in which the moon completes her circuit of the stellar heavens. For about a fortnight the moon is above the horizon longer than she is below the horizon, while during the next fortnight she

is below the horizon longer than she is above the horizon. Now, clearly, when the length of what we may call the moon's diurnal path (meaning her path above the horizon), is lengthening most, the time of her rising on successive nights must change least. She comes to the south later and later each successive night by about 50½ minutes, because she is always traveling towards the east at such a rate as to complete one circuit in about four weeks; and losing thus one day in 28, she loses about 50½ minutes per day. If the interval between her rising and arriving to the south were always the same, she would rise 50½ minutes later night after night. But if the interval is lengthening, say 10 minutes per night, she would of course rise only 40½ minutes later; if the interval is lengthening 20 minutes per night she would rise only 30½ minutes later, and so forth. But the lunar diurnal arc *is* lengthening all the time she is passing from her position farthest south of the equator to her position farther north, just in the same way as the solar day is lengthening from midwinter to midsummer, only to a much greater degree. And as the solar day lengthens fastest at spring when the sun crosses the equator from south to north, so the time the moon is above the horizon lengthens most, day by day, when the moon is crossing the equator from south to north. It lengthens, *then*, from an hour to an hour and 20 minutes in one day, that is the interval between moonrise and moonsetting increases from 30 to 40 minutes. At this time, then, whenever it happens in each lunar month, the moon's time of rising changes least—instead of the moon rising night after night 50½ minutes later, the actual difference varies only from 10 to 20 minutes.

Now when this happens at a time when the moon is not nearly full, it is not specially noticed, because the moon's light is not then specially useful. But if it happens when the moon is nearly full, it is noticed, because her light is then so useful. A moon nearly full, afterwards quite full, and then for a day or two still nearly full, rising night after night at nearly the same time, remaining also night after night longer above the horizon, manifestly serves man for the time being in the most convenient way possible. But it is clear that as the full moon is opposite the sun, and as to fulfill the condition described we have seen that she must be crossing the equator from south to north, the sun, opposite to her, must be at the part of his path where he crosses the equator from north to south. In other words, the time of year must be the autumnal equinox. Thus the moon which comes to "full" nearest September 22 or 23 will behave in the convenient way described. At this time, moreover, when she rises night after night at nearly the same time, the nights are lengthening the fastest while the time the the moon above the horizon is lengthening still more — and, therefore, in all respects the moon is then doing her best, so to speak, to illuminate the nights. At this season the moon is called the harvest moon, from the assistance she sometimes renders to harvesters.

The moon which is full nearest to September 22–23, may precede or follow that date. In the former case only can it properly be called a harvest

moon. In the latter it is sometimes called the hunter's moon. The full moon occurring nearest to harvest time will always partake more or less of the qualities of a full moon occurring at the autumnal equinox, and similarly of a full moon following the autumnal equinox. So that, in almost every year, there may be said to be a harvest moon and a hunter's moon. But, of course, it will very often happen that in any particular agricultural district the harvest has to be gathered in during the wrong half of the lunar month, that is, during the last and first, instead of the second and third quarters.

The reader must not fall into the mistake of supposing, as I have seen sometimes stated in text-books of Astronomy, that we are more favored in this respect than the inhabitants of the southern hemisphere. It is quite true that the same full moon shines on us as on our friends in New Zealand, Australia, and Cape Colony, and also that our autumn is their spring, and their spring our autumn. But the full moon we have in autumn behaves in the southern hemisphere not as with us, but as our spring moon behaves; and the full moon of our spring, which is their autumn, behaves with them as our autumn moon behaves with us. It is, therefore, for them a harvest moon if it occur before the equinox, and a hunter's moon if it occur after the equinox. A very little consideration will show why this is. In fact if, in the explanation given above, the words north and south be interchanged, and March 21–22 written for September 22–23, the explanation will be precisely that which I should have given respecting the harvest (or March) moon of the southern hemisphere, if I had been writing for southern readers.

GEOLOGY.

On Critical Periods in the History of the Earth, and their Relation to Evolution; On the Quaternary as Such a Period.

BY JOSEPH LECONTE.

[CONTINUED.]

I have preferred, thus far, to speak of *general* evolution-changes of organisms, whether slow or rapid, as produced by varying pressure of external conditions, and of the most striking *local* changes by migration from other regions, where the apparently suddenly-appearing species had previously existed, having originated there by evolution in the usual way. I have chosen, thus far, to represent the organic kingdom as lying, as it were *passive* and plastic under the molding hands of the environment. I have done so because it is in accordance with true method to exhaust the more obvious causes of evolution before appealing to the more obscure and doubtful.

It is possible that general movements affecting alike all classes may be accounted for in this way alone. But there are many facts in the evolution of the organic kingdom, especially the sudden appearance of new forms in the quietest times, which can hardly be thus explained. There seem to be *internal* as well as *external* factors of evolution. Again, the internal factors may be either in the form of *tendencies* to change or of *resistance* to change. Of these, however, the latter seems to be most certain. There may be in the organic kingdom an "*inherent tendency*" to change in special directions, similar to that which directs the course of embryonic evolution,—a tendency, in the case of the organic kingdom, inherited from physical nature from which it sprang, as in the case of the embryo it is inherited from the organic kingdom through the line of ancestry. This cause, however, is too obscure, and I therefore pass it by.

But whether or not there be any such inherent tendency to change, there certainly is an inherent tendency to *stability*,—to persistence of organic form. If there be no inherent force of progress, there certainly is an inherent force of *conservation* greater in some species than in others. It seems probable that in many of the more rigid types this stability is so great, and therefore variation of offspring so slight, that progressive change of form is too slow to keep pace with change of external conditions, especially in critical periods. If this be so, then an organism may be regarded as under the influence of two opposing forces: the one conservative, the other progressive; the one tending to equilibrium, the other to motion; the one to permanence, the other to change of form; the one static, the other dynamic; the one internal, *the law of heredity*, the other external, *the pressure of a changing environment*. Under the influence of two such forces, the one urging, the other resisting, it is evident that even with steady changes of external conditions the change of organic forms would be more or less paroxysmal. Other kinds of evolution, physical and social, evidently advance paroxysmally from this cause. As, therefore, in the gradual evolution of earth-features there are periods of comparative quiet, during which the forces of change are gathering strength but produce little visible effect, being resisted by crust-rigidity, and periods when the accumulating forces finally overcome resistance and determine comparatively rapid changes; as in social evolution there are periods in which forces of social change are gathering strength but make no visible sign, being resisted by social conservatism,—rigidity of the social crust,—and periods in which resistance gives way and rapid changes occur, so also in the evolution of the organic kingdom the forces of change, that is, pressure of changing environment, may accumulate but make little impression, being resisted by the *law of heredity*—of *like producing like*—or type-rigidity, until, finally, the resistance giving way, the organic form breaks into fantastic *sports* which are at once seized by natural selection, and rapid change is the result.

Some persons seem to think that paroxysmal evolution is inconsistent with the uniformity of nature's laws. On the contrary, it is in perfect accord.

Laws and forces are indeed uniform, but phenomena are nearly always paroxysmal. The forces of volcanoes and earthquakes, of lightning and tempest, are uniform, but the phenomena are paroxysmal. Winds at the earth's surface, where the resistance is great, *blow in puffs*. A thin sheet of water over a smooth sloping surface *runs in waves*. The law may be illustrated a thousand ways. In all cases where an accumulating force is opposed by a constant resistance, we have phenomena in paroxysms.

But whatever be the cause, the *fact* of paroxysmal movement of organic evolution is undoubted. All along the course of geological history, from beginning to end, even when the times were quietest, where the record is fullest and apparently without any missing leaf, species come and go and others take their place, and yet only rarely do we find any transition steps. If this were merely once or twice or thrice, or to any extent exceptional, it might be explained by loss of record here and there, but it occurs thousands and tens of thousands of times. Now, if evolution moves only at uniform rate, if it takes one hundred thousand years to transmute one species into another (as it certainly does when evolution is moving at its usual rate), if there are at least one hundred thousands steps (represented each, of course, by a whole generation of many individuals) between every two consecutive species, it is simply incredible that all the individuals representing the intermediate steps, so infinitely more numerous than the species they connect, should be so generally, almost universally, lost. But the phenomena, as we find them, are easily understood if a few generations represent the transition step, and many generations the permanent form.

A similar rapid, almost sudden, appearance and extinction of *genera*, *families*, and higher groups at certain horizons, are also common. In these cases the intermediate steps of transition are often found, and constitute, in fact, the chief demonstrative evidence of the truth of evolution. But the difficulty on the assumption of a uniform rate of evolution is none the less here, for the time required to evolve a new genus or a new family is, of course, immensely greater than in the case of a new species.

We will illustrate the difficulties of the ordinary view by one striking example. In the Upper Silurian, in the midst of a conformable series,—where if there be any break, any lost record, surely it must be very small,—appear suddenly, without premonition, *fishes;* not a connecting link between fishes and any form of invertebrates, but perfect, unmistakable fishes. Here we have, therefore, the appearance not only of a new class, but of a new sub-kingdom or type of structure, *Vertebrata*. Now, to change from any previously existing form of invertebrate, whether worm, crustacean, or mollusk, into a vertebrate, by a series of imperceptible steps represented by successive generations,—steps so imperceptible that it would take one hundred thousand of them to advance from one intermediate species to an other,—would require an amount of time which is inconceivable to the human mind, and a number of steps, each be it remembered, represented by thousands of individuals, which can scarcely be expressed by fig-

ures. And yet we must believe that these innumerable transitional forms, each represented by innumerable individuals, are all lost, and that this prodigious time shows no evidence in the rocky record. If this case were exceptional we might possibly admit that fishes appeared in Great Britain by migration (as they probably did), but only after having previously existed untold millions of ages somewhere else; but similar cases are too common to be explained in this way.

Now the whole difficulty disappears,—we avoid the incredible imperfection of the geological record (imperfect at best); we avoid also the necessity of extending geological time to a degree which cannot be accepted by the physicist,—if we admit that the derivation of one species from another is not necessarily by innumerable imperceptible steps, but may sometimes be by a *few decided steps;* and that the same is true for the origin of new genera, families, orders, etc.; in a word, that there are in the history of evolution of species genera, families, orders, etc., and of the organic kingdom *periods of rapid movement*. When the whole organic kingdom is involved in the movement, then we call the period *critical*, and the record of it is often lost.

Thus, on the supposition of such rigidity or resistance to change in organic forms, varying in degree in different species and in different genera, families, orders, etc., a rigidity, also, increasing by accumulated heredity so long as conditions remain unchanged, it is evident that, in times of perfect tranquillity all species grow more and more rigid. In times of very gradual change the more plastic species change gradually *pari passu*, while the more rigid species change paroxysmally, now one, now another, as their resistance is overcome. Finally, in times of revolution nearly all forms yield to the pressure of external conditions and change rapidly, only the very exceptionally rigid being able to pass over the interval to the next period of readjusted equilibrium.

Thus, for example, the great and wide-spread changes of physical geography which occurred at the end of the Carboniferous, appropriately called in this country the *Appalachian revolution*, were the death-sentence of the long continuing and therefore rigid Palæozoic types. But the sentence was not immediately executed. The Permian represents the time between the sentence and the execution,—the time during which the more rigid Palæozoic forms continue to linger out a painful existence in spite of changed and still changing conditions. But the most critical time—the time of the most rapid change, the time of actual execution—was the *lost interval*. Only a very few most rigid forms pass over this interval into the Trias.

The Quaternary, a Critical Period. We have given examples of several general unconformities, the signs of wide-spread oscillations of the earth-crust, attended with increase and decrease of land, and therefore with great and wide-spread changes of climate and other physical conditions, and also with great and rapid changes of organic species. These times of general oscillation are therefore the natural boundaries of the Eras or primary divisions of time. We have called them critical periods, transition periods,

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periods of revolution, because they are times of rapid change, both in the physical and organic world,—a change overthrowing an *old* and establishing a *new* order of things. They are also times of *lost record*. We have seen that these critical periods, in comparison with the preceding and succeeding, are *continental periods*, and it is for this reason that their record is usually lost.

Now, the Quaternary is such a critical or transition period, marking the boundary between two great eras. The Quaternary is also a period of great and wide spread oscillations, with increase and decrease of land,—a period of upheaval, erosion, down-sinking, to rise again slowly to the present condition. The early Quaternary was therefore, to a marked degree a continental period. Here also we have newer rocks lying unconformably on the eroded edges of an older series—river sediments in old river-valleys, marine sediments in fiords; in other words, we have unconformity on a grand scale. Also, in connection with these oscillations, we have great changes in physical geography, and corresponding and very wide-spread changes in climate, and consequently corresponding rapid changes in organic forms. Here, then, we have all the characteristics of one of the boundaries between the primary divisions of time. We have a transition or *critical* period,—a period corresponding to one of the lost intervals; only in this instance, being so recent and being also less violent than the preceding ones, it is not lost. From this it follows that the study of the Quaternary ought to furnish the key which will unlock many of the mysteries which now trouble us. Some of the problems which have been or will be explained by study of the Quaternary we will now briefly mention.

I. *Changes of Species not sudden.* If the Quaternary were lost, and we compare the Tertiary rocks with the unconformably overlying recent rocks, and the Tertiary mammals with those now living, how great and apparently sudden seems the change! How like to a violent extermination and re-creation! But the Quaternary is fortunately not lost, and we see that there has been no such wholesale extermination and re-creation, but only gradual though comparatively rapid transition.

II. *Migration One Chief Cause of Change.* But what is sitll more important, we are able to trace with something like certainty the cause of these rapid changes, and we find that in the higher animals, chief among these causes have been *migrations*,—migrations enforced by changes of climate, and migrations permitted by changes of physical geography opening gateways between regions previously separated by impassable barriers. This point is so important that we must dwell upon it. Only an outline, however, of some of these migrations and their effects on evolution can be given in the present condition of knowledge.

During Miocene times, as is well known, evergreens, allied to those now inhabiting Southern Europe, covered the whole of Europe as far north as Lapland and Spitzbergen. In America, Magnolias, Taxodiums, Libocedrus, and Sequoias very similar to, if not identical with, those now living on the

Southern Atlantic and Gulf coasts and in California were abundant in Greenland. Evidently there could have been no *Polar ice-cap* at that time, and consequently no arctic species unless on mountain tops. During the latter part of the Pliocene the temperature did not differ much from the present; the Polar ice-cap had therefore commenced to form, with its accompaniment of arctic species. With the coming on of the *Glacial epoch*, the polar ice and arctic conditions crept slowly southward, pushing arctic species to Middle Europe and Middle United States, and sub-arctic species to the shores of the Mediterranean and the Gulf. With the return of more genial climate, arctic conditions went slowly northward again, and with them went arctic species slowly migrating, generation after generation, to their present arctic home.

Similarly, molluscous shells migrated slowly southward and again northward to their present position. But *plants* and some terrestrial invertebrates, such as insects, had an alternative which shells had not, namely, that of seeking arctic conditions also *upward* on the tops of mountains. Many did so, and were left stranded there until now. It is in this way that we account for the otherwise inexplicable fact that Alpine species in Middle Europe are similar or even largely identical with those in the United States, and also with those now living in arctic regions. These species were wide-spread all over Europe and the United States in Glacial times; and while some of them afterward went northward to their present home, some in each country sought arctic conditions in Alpine isolation. This explanation, which has been long recognized for plants, has been recently applied by Mr. Grote to arctic insects found on the top of Mt. Washington and the mountains of Colorado.*

Undoubtedly changes of climate during this time enforced similar migrations among mammals also. But it is evident that while plants and invertebrates might endure such modifications of climate and such enforced migrations with little alteration of form, the more highly organized and sensitive mammalian species must be either destroyed or else must undergo more profound changes. Moreover, the opening of land connections between regions previously isolated by barriers would be far more quickly taken advantage of by mammals than by invertebrates and plants. The migrations of plants are of necessity very slow, that is, from generation to generation. The migrations of mammals, too, so far as they are *enforced* by changing climate, are of a similar kind; but the voluntary migrations of mammals, *permitted* by removal of barriers, may take place much more rapidly, even in a few generations. This introduces another element of very rapid local change, namely, the *invasion* of one fauna by another equally well adapted to the environment, and the struggle for life between the invaders and the autochthones.

* This application, with reference to Mt. Washington and other arctic insects in America, was previously made by Prof. A. S. Packard, Jr, in the Memoirs of the Boston Soc. Nat. Hist., i. p. 256. 1867.—Ed. American Naturalist.

For example: in America during the Glacial epoch, coincidently with the rigorous climate, there was an elevation of the continent, greatest in region of high latitude, but also probably great along the line of the Mississippi River; for in this region it extended southward even to and beyond the shores of the Gulf. Prof. Hilgard has shown that the elevation at the mouth of the Mississippi River was at least four hundred and fifty to five hundred feet above the present condition. Until the Glacial times the two Americas were certainly separated by sea in the region of the Isthmus, as shown by the Tertiary deposits there. This barrier was removed by upheaval during the Glacial epoch, and a far broader connection existed *then* than now. Through this open gate-way came the fauna of South America, especially the great Edentates, into North America. Similarly a broad connection then existed between America and Asia in the regions of the shallow sea between the Aleutian Isles and Behring Strait. Through this gate-way came an invasion from Asia, including probably the mammoth. With this invasion probably came also man. It seems probable, therefore, that the earliest remains of man in America will be found on the Pacific coast.

Also the great Pliocene lake, which stretched from near the shores of the Gulf far into British America, and possibly into arctic regions, and formed a more or less complete barrier to the mammalian fauna east and west *was abolished* by upheaval, and free communication was established. It is impossible that all these changes of climate and all these migrations partly enforced by changes of climate and partly permitted by removal of barriers, and in this latter case especially attended with the fiercest struggle for life, should not produce rapid and profound changes in the mammalian fauna.

In Europe the process has been more accurately studied and is better known. In Quaternary times at least four different mammalian faunæ struggled for mastery of European soil. (1.) The Pliocene autochthones. (2.) Invasions from Africa by opening of gate-ways through the Mediterranean: one by way of Italy, Sicily, and Malta and one by Gibraltar, both of which have been again closed. (3.) Invasions from Asia, by removal of a great sea barrier connecting the Black and Caspian seas with the Arctic Ocean. This gate-way has remained open ever since. (4.) Invasions from arctic regions, enforced by changes of climate. Probably more than one such invasion took place; certainly, one occurred during the second Glacial epoch. The final result of all these climatic changes and these struggles for mastery was that the Pliocene autochthones, adapted to a more genial climate, were mostly destroyed or else driven southward with some change into Africa: the African invaders were driven back also into Africa, and with some Pliocene autocthones isolated there by subsidence in the Mediterranean region closing the southern gate-ways, and still exist there under slightly modified forms; the Arctic invaders were again driven northward by return of more genial climate, and there exist to this day; while the Asiatics remain masters of the field, though greatly modified by the conflict.

Or perhaps, more accurately, we might say that the existing European mammalian fauna is a resultant of all these factors, but the controlling factor is the Asiatic. With the Asiatic invasion came man, and was a prime agent in determining the final result.

Thus, regarding the Tertiary and the Present as consecutive eras, and the Quaternary as the transition or critical period between, then, if the record of this period had been lost, corresponding with the unconformity here found, we should have had here an enormous and apparently sudden change of mammalian species. Yet this change of fauna, as great as it is, is not to be compared with that which occurred between the Archæan and Palæozoic, or between the Palæozoic and Mesozoic, or even that between the Mesozoic and Cænozoic; for the change during the Quaternary is mostly confined to species of the higher mammals, while the change during previous critical periods extended to species of all grades, and not only to species, but to genera, families, and even orders. We conclude, therefore, that the previous critical periods or lost interrals were far longer than the whole Quaternary; or else that the rate of evolution was far more rapid in these earlier times.

To sum up, then, in a few words, the general formal laws of evolution-change throughout the whole history of the earth:—

(1.) Gradual, very slow changes of form everywhere under the influence of all the factors of change, known and unknown: for example, pressure of changing physical conditions whether modifying the individual (certainly one factor), or selecting the fittest offspring (certainly another factor); improvement of organs by use and the improvement inherited (certainly a third factor), and perhaps still other factors yet unknown. This general evolution by itself considered would produce similar changes everywhere, and therefore would produce geological faunæ, but not geographical diversity. Determination of a geological horizon would in this case be easy, because fossil species would be everywhere identical.

(2.) Changes in different places and under different physical conditions, taking different directions and advancing at different rates, give rise to *geographical faunæ*. This, if there were nothing more, would produce far greater geographical diversity and more complete localization of faunæ and floræ than now exist,—so great that the determination of a geological horizon would be impossible.

(3.) The force of change resisted by heredity, in some species and genera more than in others, determines paroxysms of more rapid movement of general evolution, affecting sometimes species, sometimes genera or families. The sudden appearance of species, genera, families, etc., in quiet times is thus accounted for.

(4.) *During critical periods*, oscillations of the crust, with rapid changes of physical geography and climate, determine a more rapid rate of change in all forms; first, by *greater pressure of physical conditions;* and, second, by *migrations* partly enforced by the changes of climate and partly permitted by removal of barriers, and the consequent *invasion* of one fauna and flora

by another and *severe struggle* for mastery. This would tend to *equalize again* the extreme diversity caused by the second law; but the effect would be more marked in the case of the animals than plants, because voluntary migrations are possible only in this kingdom. Hence it follows that a geological horizon is far better determined by the fauna than by the flora.

III. *Historic value of the Present Time.* Most geologists regard the Present as one of the minor subdivisions of the Cænozoic era, or even of the Quaternary period. More commonly the Quaternary and Present are united as one age—the age of man—of the Cænozoic era. The Cænozoic is thus divided into two ages: the age of mammals commencing with the Tertiary, and the age of man commencing with the Quaternary; and the Quaternary subdivided into several epochs, the last of which is the Present or Recent. But if the views above expressed in regard to critical periods be correct, then the present ought not to be connected with the Quaternary as one age, nor even with the Cænozoic as one era, but is itself justly entitled to rank as one of the *primary divisions* of time, as one of the great eras separated like all the other eras by a critical period; less distinct it may be, at least as yet, in species than the others, the inaugurating change less profound, the interval less long, but dignified by the appearance of man as the dominant agent of change, and therefore well entitled to the name *Psychozoic* sometimes given it. The geological importance of the appearance of man is not due only or chiefly to his transcendent dignity, but to his importance as an agent which has already very greatly, and must hereafter still more profoundly modify the whole fauna and flora of the earth. It is true that man first appeared in the Quaternary, but he had not yet established his supremacy; he was still fighting for mastery. With the establishment of his supremacy the reign of man commenced. An age is properly characterized by the *culmination*, not the first apperance, of a dominant class. As fishes existed before the age of fishes, reptiles before the age of reptiles, and mammals before the age of mammals, so man also appeared before the age of man.

We therefore regard the Cænozoic and Psychozoic as two consecutive eras, and the Quaternary as the critical, the revolutionary, or transitional period between. But since the record of this last critical period is not lost, and we must place it somewhere, it seems best to place it with the Cænozoic era and the mammalian age, and to commence the Psychozoic era and age of man with the completed supremacy of man, that is, with the Present epoch.

BERKELEY, CALIFORNIA, March 15, 1877.

ARCHÆOLOGY.

THE MOUND BUILDERS IN MISSOURI.*

BY H. N. RUST, CHICAGO.

The wide extent of country in which the mound-builders' relics of Missouri have been found forbid detailed account of each locality. The principal discoveries have been made in Scott and Mississippi counties, and within about twenty miles of Charleston. The first considerable discovery was early last season, in a dense cypress swamp known as Northcot's swamp, six miles west of Charleston. It is a part of that low country lying between Cape Girardeau and New Madrid, and which was partly submerged by the earthquake of 1811. The swamp is from one to one and one-half miles wide and covered with a heavy growth of timber, mostly cypress. There are patches of sandy land in this swamp upon which I am told there are many mounds, some of which are fifty feet high; but it is very difficult to reach them except when the swamp is frozen.

I have never seen a more undesirable place occupied by mankind. On one of the tracts of sand land we found a cleared field of about 40 acres. This field is partly surrounded by a ditch 12 to 18 inches deep, the earth which was thrown out of it forming a corresponding embankment. Within this area are two large mounds, the one a truncated pyramid, about fifteen feet high and 75 feet in its longest diameter. This was cleared of timber about forty years ago, and having been ploughed and cultivated since, has been much reduced in its height and shape. On this mound we found beds of ashes, a few flint chips and arrow heads and many fragments of pottery. Seventy-five feet westerly from this mound is a large grave; 100 feet easterly was found still another, both in the level plain. About 75 feet south of this mound is a small pond of water, perhaps 60 feet in diameter and very near circular in form. Here, I imagine the earth was taken out to build the next mound, which is sixty feet southeast of the pond, and is conical in form, 15 feet high and about 40 feet in diameter.

An examination of both these mounds failed to discover any thing of interest. Upon the last mentioned mound stands an oak tree which measured 3½ feet in diameter. This and other trees of corresponding size standing upon the graves in the level plain are the most positive evidences I could gather of the antiquity of these graves. About 50 feet east of the last mentioned mound in the level plain was discovered the first grave in this field. Here within a circle, the diameter of which is 75 feet, was found several hundred skeletons and a great variety of pottery, with comparatively few stone implements.

* Read before the American Association for the Advancement of Science, Sept. 4, 1877.

Quite near this grave and a little south are a series of depressions and hillocks, five or six each in continuous line, alternating as if the earth from each depression formed the next hillock.

These are ten to twelve feet in diameter and in the center, being the lowest point, about eighteen inches deep. These were not noticeable upon my first visit, but the timber having been cleared off last winter, they can now be plainly seen.

The surface has been recently ploughed, but I was unable to discover any indications here more than elsewhere that they had been the site of human habitations.

A few rods south within the timber another large grave was found, and about one-eighth of an acre has been dug over, and large trees undermined and thrown down to secure the pottery which was buried here long years before these trees had life.

A few isolated graves, where from one to six bodies were deposited, have been found in the field, but the four mentioned are the principal ones discovered in this vicinity, and each contained several hundred bodies.

A general description of the forms of burial and deposit may be applied to all the graves I have seen in Missouri. The largest deposits have been found rather in the level plain or in elevations varying from 18 inches to 4 feet high (with one exception.) In many instances the elevation is so slight and irregular as scarcely to be noticed. The graves were found to be from 18 inches to 4 feet deep. In all instances the bodies were buried in a horizontal position, but in nothing like regular order. Sometimes in going down 4 feet we would find 4 to 5 skeletons at different levels, and all lying in different directions. The bones were generally so much decomposed that they could be saved only by the greatest care. Sometimes we could not lift them before they would crumble to dust. Some were so far decomposed that only a colored line in the earth was distinguishable. Yet the pottery which was almost invariably deposited near the head of each individual remained complete. I was able to preserve a few skulls in a very good state of preservation by carefully drying them in the sun immediately after taking them from the earth and later dipping them in a solution of common glue. These are widely different in form, but the most noticeable irregularity is a depression upon the back side, sometimes from left to right, sometimes in the opposite direction. My first impression was that this flattening process was during lifetime, but upon a more extended observation I came to believe it was done by the weight of the earth, when the bone was softened by long continued moisture.

Two days ago I opened several of the stone graves in this vicinity and noticed the same depression in each instance, the principal difference here being that the depression was greater and in some instances the skull was entirely crushed. Here the earth is less yielding than the sandy soil of Missouri and in some instances these stone graves have a stone floor—I imagine that certain conditions of the soil were better calculated to preserve

both bone and pottery than others, as we found that the dry sandy soil furnished better preserved bones and pottery than that which was found where the earth was more moist and heavier. We saw no marks of violence upon the bones such as would indicate a violent death. As before remarked, we found that in nearly every instance from one to three articles of pottery were deposited near the head of each individual. The most common form of which is the jug or water cooler. Next, the open dishes without ornament or handle, a large proportion of which were broken when found, probably by action of frosts and weight of soil. The open dishes with four ears and a flaring rim, or with projections by which it might be suspended, are quite common. I saw only two attempts to make a square dish.

The most curious and interesting forms are the human representations, and by far the most rare. Rude and ugly as they are may they not represent the prehistoric ideal of beauty? I think we can see in some specimens a close resemblance to the ancient Peruvian pottery—a similar style of headdress is noticeable, and the humpback is very common. A few vessels are quite nicely ornamented in colors, some of which appear to have been laid on with a brush, and others are a mixture with the clay, sometimes several lines in thickness, and thoroughly baked with the vessel. All these colors are much more distinct after having been exposed to the sun than when taken from the earth.

The sun and moon are among the objects represented in colors. In some instances figures of the human head form the handles of open dishes and are nicely wrought in fine clay. In such the cavity of the head contains several little balls of clay, which make a noticeable rattle when the bowl is shaken.

We found a very good representation of a child's knit sock and the Indian moccasin, several varieties of fishes—in some specimens the scales are nicely shown. We have also the alligator, the turtle, frog and salt water clam; the opossum, the squirrel, fox, wolf, hog and beaver; the turkey, owl and duck, as well as the squash, gourd and melon. All these seem to have been favorite forms. The owl and ducks' heads often formed the handles of open dishes. All these have openings showing they were made for use. The majority will hold from one to three pints, a few large ones holding as many quarts, and some hold not more than one or two ounces. In several we found the bones of some of the small animals and fishes, and what appeared to be the remains of animal matter, which may have been deposited as food.

In some of these vessels were found small pebbles showing positive marks of having been used and evidently deposited with care, small plates of mica, very many muscle shells, and a very few beads of baked clay, others made of shells. Among the other articles found in the graves were stone spades from seven to thirteen inches long, chipped out and nicely polished by long use; the common form of spear-heads, arrow-heads and stone knives, celts and chisels, all nicely polished; pestles of pottery, which I

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judge were made to knead the clay and perhaps smoothe the surface of the pottery; several small cylindrical shaped articles, about one inch in length, which reminds us of a bottle stopper, and may have been worn in the ear or lip as ornaments. I have one made of shell, one of Fluor Spar, and several of pottery, all about the same size; smooth stones weighing from one to ten ounces are found bearing marks of long use; flat stones about the size of the palm of the hand with a depression on each side—may have been used in grinding colors, as small pieces of red Hematite were found with them; pieces of sandstone ground, showing they had been used as whetstones; several small discoidal stones from one to one and one-half inches in diameter, some of them entirely perforated in the center; other discordels or whorls and marbles, made of clay; a small mask of same material; a few large shells from the sea, having been cut in shape to form a convenient dipper.

We found only three pieces of native copper, two of which appeared to have been used as pendant ornaments, being in the form of the sunfish, about three inches in length. On a small disc of wood about one and a half inches in diameter, was found a very thin plate of copper. This was perforated at the center.

This was all the metal found. We found several pieces of galena which had the appearance of having been worn by constant use.

Several pieces of cannel coal, wrought in curious shapes, nicely polished, still retain their smooth surface. One of these, I believe, was worn as a lip ornament.

Nothing like grain or any woven fabrics have been found to my knowledge.

About two miles north of Charleston another grave was discovered early this summer. It was in an open plain occupied as an orchard. It had been cultivated many years and the burials were very near the surface.

Three miles east of Charleston on the Mississippi bottom, or overflow, is a mound about 100 feet long by 75 feet wide, 15 feet high. Long cultivation must have much reduced its original proportions. This is the only large burial mound, to my knowledge, in this vicinity. This one seemed to have been crowded full. Here the earth is quite moist, a very heavy adhesive mixture of clay and sand. Here the bones are not as well preserved and the pottery was softer and coarser, very easily broken, but great quantities have been buried here.

About 100 feet north is a similar shaped mound, about one-half the size of the one last mentioned. Upon this lay the remains of a fallen oak not less than 3 feet in diameter. We dug about 4 feet from this stump and about 2 feet below the surface, came to the charred remains of a post or stake about 4 inches in diameter. We uncovered it about 4 feet, finding a quantity of charred human bones, and below this for about 18 inches the stake was not charred, but decayed. Very little pottery was found in this mound.

South of Charleston was a large grave in a sandy loam. Here were four small mounds, quite near together, about 4 feet high, and all burial mounds except one.

Twelve miles further south, on James bayou, are two mounds, quite near the bayou, about 8 feet high and 40 feet in diameter. Neither seemed to be burial mounds; but near by in the same field was found a large grave in a slight elevation. It extended into the street, and was so slight that one in passing would hardly notice it above the usual level. Here were several hundred good vessels found in a space not larger than 30 by 60 feet. These finds constitute the greater part of all I have examined in Missouri. I very much regret that these works could not have been more carefully and intelligently opened; but since it has been done by private enterprise alone, and no one having entire control of the premises, we could do no better.

Much of value and interest has been forever lost. My endeavor has been to preserve all the facts which came to my knowledge, and I only regret that I could not have done the work more perfectly.

EXAMINATION OF INDIAN MOUNDS ON ROCK RIVER, AT STERLING, ILLINOIS. —I recently made an examination of a few of the many Indian mounds found on Rock River, about two miles above Sterling, Illinois. The first one opened was an oval mound about twenty feet long, twelve feet wide, and seven feet high. In the interior of this I found a *dolmen* or quadrilateral wall about ten feet long, four feet high, and four and a half feet wide. It had been built of lime-rock from a quarry near by, and was covered with large flat stones. No mortar or cement had been used. The whole structure rested on the surface of the natural soil, the interior of which had been scooped out to enlarge the chamber. Inside of the dolmen I found the partly decayed remains of eight human skeletons, two very large teeth of an unknown animal, two fossils, one of which is not found in this place, and a plummet. One of the long bones had been splintered; the fragments had united, but there remained large morbid growths of bone (exostosis) in several places. One of the skulls presented a circular opening about the size of a silver dime. This perforation had been made during life, for the edges had commenced to cicatrize.

I later examined three circular mounds, but in them I found no dolmens. The first mound contained three adult human skeletons, a few fragments of the skeleton of a child, the lower maxillary of which indicated it to be about six years old. I also found claws of some carnivorous animal. The surface of the soil had been scooped out, and the bodies laid in the excavation and covered with about one foot of earth; fires had then been made upon the grave, and the mound afterwards completed. The bones had not been charred. No charcoal was found among the bones, but occurred in abundance in a stratum about one foot above them. Two other mounds examined at the same time contained no remains.

Of two other mounds opened later, the first was circular, about four feet

high, and fifteen feet diameter at the base, and was situated on an elevated point of land close to the bank of the river. From the top of this mound one might view the country for many miles in almost any direction. On its summit was an oval altar, six feet long and four and one-half wide. It was composed of flat pieces of limestone, which had been burned red, some portions having been almost converted into lime. On and about this altar I found abundance of charcoal. At the sides of the altar were fragments of human bones, some of which had been charred. It was covered by a natural growth of vegetable mold and sod, the thickness of which was about ten inches. Large trees had once grown in this vegetable mold, but their stumps were so decayed I could not tell to what species they belonged. Another large mound was opened which contained nothing.—W. C. HOLBROOK, in *American Naturalist*.

MOUND BUILDERS OF ILLINOIS.—The Chicago *Inter-Ocean* has a letter from a correspondent at Rockford, Illinois, who, under date of August 27, "The Rockford Scientific Society made an excursion last Friday to investigate the mounds which are so numerous along the banks of the Rock River. The spot chosen was about seven miles south of this city, on the river. Two mounds were opened. In the first, at a depth of five feet from the top of the mound, and about a foot below the surface of the surrounding country, detached pieces of bone were discovered, and with great care the perfect reclining form of a skeleton was excavated. The body at burial had been laid on the right side facing the sun, with legs drawn up and knees to the chin, with hands crossed in front. The skull was taken out and brought to this city, where it will be carefully examined. The teeth are in a wonderful state of preservation. It was impossible to remove the skeleton whole from its long resting place, it being as soft and frail as the mould which encased it, and only detached pieces could be secured. It is the first specimen which the society has secured of the genuine pre-historic mound builder, and that it belongs to that long extinct and mysterious race of people they have no doubt. The society also commenced the opening of a larger mound near by, but were unable to finish it. A number of large stones were found near the centre of this mound. Some of the stones were foreign to this locality and State, and were undoubtedly brought from the Lake Superior region, and for what purpose they were placed there it is not possible to conjecture until the mound is more fully opened. The society propose to continue their interesting discoveries and I will attend their investigations. Near this locality, a few days since, a party of laborers recently exhumed with a plow several skeletons which were lying near the surface, and which, from chronological appearances as well as from the fact that they were buried near the surface, were undoubtedly Indians. With these skeletons was found a pebble stone pipe of unusual polish and finish; also three hollow deers' leg bones, which had evidently been used as musical instruments of some kind, and which were perforated at regular intervals with round and square holes."

MEDICINE AND HYGIENE.

Experiments on the Effects upon Respiration of cutting off the Supply of Blood from the Brain and Medulla Oblongata.

BY AUSTIN FLINT, JR., M. D.,

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In October, 1861, I published in the *American Journal of the Medical Sciences* a paper on "Points connected with the Action of the Heart and with Respiration." In this paper, I contended that the respiratory sense (*besoin de respirer* of the French), or sense of want of air, which gives rise to the movements of respiration, is due to a want of oxygen in the general system. I assumed that the medulla oblongata is the center presiding over the respiratory movements; that these movements are reflex; that a certain sense, called the respiratory sense, is conveyed to the medulla oblongata; and that it is this sense which is the starting-point of the respiratory acts. I showed that a dog brought under the influence of ether, with the heart and lungs exposed and with a bellows in the trachea, will make no respiratory efforts so long as air is efficiently supplied to the lungs by artificial respiration, an experiment essentially the same as one made by Robert Hook, in 1664. In an animal in this condition, I showed that respiratory efforts were made, when artificial respiration was interrupted, as soon as the blood became dark in the arteries, having opened an artery and noted the color of the blood as the experiment progressed.

It seemed to me at that time that the sense of want of air in this experiment was due to the properties of the dark-colored blood circulating in the arterial system; and the question arose in my mind whether this were dependent upon the deficiency of oxygen in the blood or upon the presence of carbonic acid. In order to answer this question, I drained an animal (a good-sized dog) of blood by dividing the femoral artery, the chest having been opened with the animal under the influence of ether, and artificial respiration being maintained in the usual way. In this experiment, although the lungs were constantly supplied with air, violent respiratory efforts were made as the animal became nearly exsanguine.

In another experiment, I divided both pneumogastric nerves and ascertained that there was no difference in the phenomena observed, showing that these nerves are not the sole conductors of the sense of want of air, if, indeed, they have any part in this function. In still another experiment, I drained an animal of blood by cutting out the heart. This was followed by violent respiratory efforts, showing that the sense of want of air has nothing to do with distension of the right cardiac cavities.

From the experiments of which I have thus given a brief sketch, made

in 1861, I concluded that the sense of want of air, or the respiratory sense, was due to a want of oxygen in the general system, producing an impression which was conveyed to the medulla oblongata and which gave rise to respiratory efforts; that, in ordinary respiration, this reflex action took place unconsciously, but became exaggerated when there was a great deficiency of oxygen, and was then experienced as a sense of suffocation; that the respiratory sense thus had its origin in the general system and had nothing to do with the lungs, as the sense of thirst has its seat in the general system, from deficiency of water, and has simply a local manifestation in dryness of the throat and fauces. In addition to the experimental arguments in favor of this view, I saw, in cases of distress in breathing from deficient circulation, as in certain cases of disease of the heart in which the lungs are normal, what seemed to me to be a confirmation of my opinion.

The views which I have just stated were advanced by me in my work, "Physiology of Man," New York, 1866, vol. i., page 479, *et seq.*, and in my "Text-Book of Human Physiology," New York, 1876, page 164, *et seq.* In February, 1874, I made an address before the New York Society of Neurology and Electrology upon the "Mechanism of Reflex Nervous Action in Normal Respiration," an abstract of which was published in the *New York Medical Journal*, in April of the same year. The full text of this address was published in the *Chicago Journal of Nervous and Mental Diseases*, in April, 1874. In this, I still adhered to my original view, and I extended my reflections to the theory of the cause of the first respiration at birth, respiration by means of the placenta *in utero*, etc.

At the present day nearly all physiological writers agree that the sense of want of air is due to want of oxygen, and not to any stimulating or irritating properties of carbonic acid; and this idea has received complete confirmation from the experiments of Pflüger upon the effects of respiration of nitrogen, as is seen by the following extract:

"Using blood-letting for ascertaining the condition of the blood during dyspnœa, I arrived at the following facts: As soon as the dog begins to breathe pure nitrogen, it is scarcely fifteen seconds before he makes violent and deep inspirations; at the end of thirty seconds, the most intense dyspnœa is observed, the blood is already almost absolutely black, which must be due to the enormously-rapid tissue-metamorphosis of this animal."*

It is seen that this experiment, made in 1868, is almost identical in idea and results with those which I made in 1861, except that Pflüger made his animal breathe a gas not capable of supporting respiration, while I simply deprived animals of air. Nearly the same experiment as that performed by Pflüger was made by Rosenthal, in 1862, who noted that animals suffered no dyspnœa when air or oxygen was forced through the lungs, but that dyspnœa was manifested when nitrogen or hydrogen was used instead of oxygen.†

* Pflüger, "Ueber die Ursache der Athembewegungen, sowie der Dyspnœ und Apnœ." —*Archiv fur die gesammte Physiologie*, Bonn, 1868, Bd. i., S. 89.

† Rosenthla, "Athembewegungen," etc., Berlin, 1862, S. 4.

While physiologists are now pretty generally agreed that the sense of want of air is connected with a deficiency of oxygen in the blood of the arteries, some writers are of the opinion that the "sense" is primarily due to a want of oxygenated blood circulating in the medulla oblongata. This opinion has been advanced by some authors, but, as far as I know, it rests mainly upon theory, and has no positive experimental foundation. Since I made the experiments which form the basis of this article, I have consulted a number of systematic works upon physiology, with reference to the subject under consideration. Most of the works examined contain no very definite allusions to the respiratory sense, or at most only brief and unsatisfactory statements: but, in two, I find the following references, which are directly pertinent to the question:

"The first respiratory effort of the fœtus is thus produced by the interruption of the placental respiration, the sudden deficiency of the oxygen and increase of carbonic acid in the blood (Schwartz). This change in the blood needs to take place locally only in the vessels of the medulla oblongata, in order to produce this effect; it occurs, for example, from arrest of the blood in these vessels (by ligature of the carotid arteries, Kussmaul and Tenner, Rosenthal, or by closure of the venous currents from the brain, Hermann and Escher), by which their blood becomes progressively poorer in oxygen and richer in carbonic acid" (Hermann, "Grundiss der Physiologie des Menschen," Berlin, 1870, S. 160).

"If the supply of blood be cut off from the medulla by ligature of the blood-vessels of the neck, dyspnœa is produced, though the operation produces no change in the blood generally, but simply affects the respiratory condition of the medulla itself, by cutting off its blood-supply, the immediate result of which is an accumulation of carbonic acid and a paucity of available oxygen in the protoplasm of the nerve-cells in that region" (Foster, "A Text-Book of Physiology," London, 1877, p. 254).

These quotations from Hermann and from Foster show clearly that their idea is, that the sense of want of air is due to deficiency of oxygenated blood in the medulla oblongata, a view fully sustained by my own experiments. The observations of Kussmaul and Tenner, referred to by Hermann, were made with reference to the cause of the convulsions which so often occur after profuse and sudden hæmorrage. They are to be found in the elaborate memoir by Kussmaul and Tenner, "On the Nature and Origin of Epileptiform Convulsions, caused by Profuse Bleeding," translated and published by the "New Sydenham Society," in 1859. Kussmaul and Tenner made a large number of experiments upon rabbits and horses, in which they observed the effects of tying the great vessels given off from the arch of the aorta. They noted, after this operation, great difficulty in respiration and violent convulsions. They did not, however, abolish the respiratory movements of the animal by artificial respiration, thus abolishing, for the time, the respiratory sense, and then note the effect of ligature of these vessels. The experiments by Rosenthal, which are referred to, are proba-

bly those contained in his work on "Die Athembewegungen und ihre Beziehungen zum Nervus Vagus," Berlin, 1862. In these experiments, as I have already stated, it is shown that the respiratory efforts of an animal can be abolished by forcing atmospheric air or oxygen in large quantities through the lungs, but that the sense of want of air is felt when, in place of oxygen, nitrogen or hydrogen is employed, by this means removing the possibility of an irritation from carbonic acid. These are essentially the same as the observations made by Pflüger, in 1868. Rosenthal states very distinctly that the sense of want of air is due to want of oxygen-carrying blood in the medulla oblongata; but he does not actually demonstrate the truth of this proposition by experiments. The statements by Hermann and by Foster are apparently based upon the experiments of Kussmaul and Tenner and of Rosenthal; but I must nevertheless claim that the experiments which I have made upon this subject, which will be detailed farther on, if they should be confirmed, afford the first positive proof that the respiratory sense may be excited by cutting off the arterial supply from the medulla. There is nothing which I can find, in the experiments of Kussmaul and Tenner or of Rosenthal, to actually show that the sense of want of air is not due to a want of oxygen in the general system.

In reflecting upon this subject during the last few months, it occurred to my mind that the the question was capable of a positive solution by experiment. If it be possible to cut off the arterial supply to the head and medulla oblongata, leaving the rest of the circulation free, an animal should make respiratory efforts, even though air be supplied to the lungs, provided that the sense of want of air be due to a want of oxygenated blood in the medulla. On the other hand, if the sense of want of air be due to a want of oxygen in the general system, cutting off the arterial supply from the head and medulla would have no more effect than cutting off the supply of oxygen from any other equally extensive part of the system. In reducing this idea to the project of an actual experiment, I conceived the following: I proposed to tie all the vessels that could by any means supply the medulla oblongata with blood (the vessels given off from the arch of the aorta), and note the effects; and then to tie the descending aorta in the chest, and note the effects, leaving the vessels coming from the arch of the aorta free. It seemed to me that, if the respiratory sense were due to want of oxygen in the general system, tying the aorta in the chest would induce respiratory efforts certainly as promptly as cutting off the arterial supply from the medulla. With the view of settling this question, if possible, I made the following experiments, which, as far as they go, are exceedingly definite and satisfactory in their results. I propose, however, to extend these experiments, and I publish them now simply as preliminary to farther investigations into the subject under consideration:

EXPERIMENT I., *September* 30, 1877.—A medium-sized, full-grown dog was brought completely under the influence of ether. The trachea was then opened and connected with a bellows, and artificial respiration was main-

tained. Over the valve of the bellows was placed a sponge, which was saturated with ether from time to time, so that the animal was kept completely anæsthetized during the experiment. The air in the bellows was also changed from time to time by pushing up the valve with the fingers and forcing out the vitiated air. The chest and abdomen were then laid open by a continuous incision in the median line, and the ribs were bent backward and secured with a strong cord tied behind the back, so that the lungs and heart were fully exposed. The pericardium was then cut away, the great vessels near the heart were isolated, and loose ligatures were thrown around the trunk of the innominate artery, the left subclavian artery, the descending vena cava, the descending portion of the aorta, and the ascending vena cava.* In this way, I was prepared to constrict the several vessels at will.

When these preliminary steps had been completed, the animal being entirely under the influence of ether and artificial respiration being kept up efficiently, there were absolutely no respiratory efforts, and the diaphragm, which was exposed, was quiescent.

The artificial respiration was then arrested. In forty-five seconds, the animal began to make violent respiratory efforts. Artificial respiration was then resumed, and the respiratory efforts of the animal ceased. When the artificial respiration was arrested, we first noticed a movement of the corners of the mouth at regular intervals, and then the mouth was widely opened and the diaphragm became strongly contracted, also at regular intervals. The time was taken at the first violent respiratory effort.

The animal being perfectly quiet and making no efforts at respiration, the innominate artery, the left subclavian artery, and the descending vena cava, were tied nearly simultaneously, artificial respiration being constantly and efficiently maintained. In two minutes and eight seconds, the animal began to make respiratory efforts, which continued as long as the vessels remained constricted.

The ligatures surrounding the vessels mentioned above were loosened five minutes and twenty-two seconds after they had been tied, and the respiratory efforts of the animal instantly ceased. After three minutes, artificial respiration was stopped, and the animal began to make respiratory efforts in thirty-nine and a half seconds, which ceased as soon as artificial respiration was resumed.

The descending aorta and the ascending vena cava in the chest were then tied simultaneously, the vessels arising from the arch of the aorta being free. This seemed to produce no effect, and no respiratory efforts were made by the animal for five minutes. The innominate artery and the left subclavian artery were then constricted, the aorta and ascending vena cava remaining tied. Respiratory efforts by the animal began in one minute

*In the dog, the aorta gives off the innominate artery "which gives off first the left carotid, and then divides into the right subclavian and right carotid" (Foster, "Elementary Practical Physiology," London, 1876, p. 13). The left subclavian artery arises directly from the aorta.

and twenty-six seconds, although artificial respiration was maintained. These efforts ceased when the ligatures around the innominate and subclavian were loosened.

The ligatures were then removed from the descending aorta and ascending cava vena, and the innominate and left subclavian arteries were constricted, which was followed by respiratory efforts after one minute and six seconds. These efforts ceased when the vessels were freed.

The innominate artery alone was then constricted, but this seemed to produce no effect, no respiratory efforts being made by the animal for five minutes. At the end of five minutes, the left subclavian artery was constricted, the constriction of the innominate artery being maintained. The animal began to make respiratory efforts fifty-three seconds after constriction of the subclavian. These efforts ceased on loosening the ligatures.

Artificial respiration was then stopped, and the animal began to make respiratory efforts in ten seconds. The medulla oblongata was then broken up, and the experiment was concluded.

In this experiment I had the aid of my able assistant, Dr. C. F. Roberts, and of Mr. Gaspar Griswold, an advanced laboratory student. As the experiment progressed, it was ascertained that the vessels could be effectually constricted by making traction on the ligatures without tying. The constriction could then be instantly removed. It was also ascertained that constriction of the veins made no difference in the phenomena observed.

EXPERIMENT II., *October* 2, 1877.—A medium-sized, full-grown dog was brought completely under the influence of ether. A bellows was fixed in the trachea and the chest and abdomen were opened as in the preceding experiment. These preliminary steps were completed at 11.30 A. M. Artificial respiration, which had been kept up with the bellows, was arrested, and the animal made efforts at respiration in thirty-seven and three-fifths seconds, having previously been quiet. The innominate artery and the left subclavian artery were then constricted, the artificial respiration being continued, and the animal made respiratory efforts in two minutes and five seconds, having previously been rendered quiet by artificial respiration. After a few respiratory efforts, the ligatures were loosened, and the animal became perfectly quiet, artificial respiration being continued. While the animal was perfectly quiet, artificial respiration being continued, the descending aorta was tied in the chest. The aorta was constricted for five minutes, and no effect was observed, artificial respiration being maintained, and the animal remaining perfectly quiet. The heart was then cut out, the system being thus drained of blood, and the animal made respiratory efforts in twenty-five seconds.

This experiment was a public demonstration made in a lecture before the class at the Bellevue Hospital Medical College; and I was assisted by Dr. C. F. Roberts, Mr. Gaspar Griswold, Dr. G. S. Conant, and Mr. W. L. Wardwell. The experiment was essentially a repetition of Experiment I., and the results of the two observations were nearly identical.

The two experiments just detailed show that ligature of the aorta has no sensible effect upon respiration; but that ligature of all the vessels given off from the arch of the aorta, which, it would seem, must cut off the supply of oxygenated blood from the brain and the medulla oblongata, produces a sense of want of air, which gives rise to respiratory efforts, even while artificial respiration is efficiently maintained. It seems, from the results observed in Experiment I., that it is not enough to tie the innominate artery, which is equivalent to tying the two common carotids and the right subclavian artery, but that it is also necessary to tie the left subclavian artery. This is explained by the fact that the left subclavian gives off the vertebral artery, which empties into the basilar artery, and thus carries oxygenated blood to the medulla oblongata.

Taking into account the fact that the sole respiratory nervous centre is situated in the medulla oblongata, the two experiments which I have described, as far as they go, seem to show conclusively that the sense of want of air is due to a deficiency of oxygenated blood in the medulla oblongata, and that this sense is satisfied by the circulation of such blood in the respiratory nervous centre.

EXPERIMENT III., *October* 7, 1877.—A full-grown young dog, weighing about thirty pounds, was brought completely under the influence of ether at 10.45 A. M., a bellows was fixed in the trachea, and the chest and abdomen were opened as in the preceding experiments. The vessels given off from the arch of the aorta were then carefully dissected out, and loose ligatures were thrown around the innominate artery, the two carotids, the right subclavian artery, the right vertebral artery, the left subclavian artery, and the left vertebral artery. These ligatures were placed around the vessels so that they might be readily found in the course of the experiment, but the vessels were not thereby constricted.

After these preparatory steps had been completed, artificial respiration was arrested, and the animal began to make respiratory efforts in thirty seconds. Artificial respiration was then resumed, and the animal became quiet.

The two subclavian arteries were then constricted with *serre-fines*, which, it was ascertained, arrested the blood current completely. The animal remained quiet for five minutes, making no respiratory efforts. The subclavians remaining constricted, both carotids were then constricted in addition. The animal made respiratory efforts in two minutes and seven seconds after constriction of the carotids. All the vessels were then freed, and the animal became quiet.

Both vertebral arteries and both carotids were then constricted for five minutes, the animal remaining quiet. These vessels remaining constricted, both subclavian arteries were constricted in addition. The animal made respiratory efforts in one minute and thirty-five seconds. All the vessels were then freed, and the animal became quiet.

At 11.40 o'clock, the descending aorta in the chest, and both subclavian

arteries were tied. This left little more than the carotids to carry blood to the head, and the arterial blood was thus cut off from the greatest part of the system. The animal remained quiet for five minutes. The experiment had now lasted fifty-five minutes, and the action of the heart had become considerably weakened. While the aorta and subclavians were still constricted, both carotids were constricted in addition. The animal remained quiet for five minutes, but the heart and great vessels up to the points of constriction were enormously distended. At the end of this time, the aorta was freed, which relieved the distension. The animal made respiratory efforts in two minutes and twenty-nine seconds, but the efforts were not very violent and were not as rapid as usual. All the vessels were freed and the animal became quiet.

Artificial respiration was then arrested, and the animal made respiratory efforts in twelve seconds. Artificial respiration was resumed, and the animal became quiet.

The innominate artery and the left subclavian artery were then constricted, and the animal made respiratory efforts in one minute and fifteen seconds, but the action of the heart had become very feeble.

The experiment had lasted one hour and fifteen minutes, and was concluded with the last observation.

In this experiment, I was assisted by Dr. C. F. Roberts, Mr. Gaspar Griswold, and Dr. G. S. Conant.

This experiment substantially confirmed the results obtained in Experiments I. and II. When the aorta, both subclavian arteries, and both carotids, were constricted, the pressure of blood in these vessels was enormous, and some blood may have found its way to the brain and medulla oblongata. The distension of the vessels was so great that this part of the experiment was not very satisfactory. Respiratory efforts were made by the animal, however, when the distension was relieved by freeing the aorta, the subclavians and the carotids remaining constricted.

In all the experiments, the animals were kept completely under the influence of ether, and artificial respiration was kept up efficiently unless otherwise stated.

Deductions and Conclusions.—When I made my first experiments upon the location of the sense of want of air which gives rise to respiratory movements, in 1861, I attached to them considerable importance, and I thought that I had proved experimentally that the sense of want of air is due to a deficiency of oxygen in the system at large. The main features of the experiments which I made at that time I have already stated. My object in making these new experiments was to study the effects of cutting off the supply of oxygenated blood from different parts.

I think it can be assumed, as I have already stated, that the sole respiratory nervous centre is in the medulla oblongata, and I endeavored to devise some means of cutting off the arterial supply of blood from this part. Animals respire when all of the encephalic centres have been destroyed except

the medulla oblongata, so that it is improbable that cutting off the supply of blood from the brain would affect the muscles of respiration, provided that artificial respiration be efficiently maintained. Blood can get to the medulla oblongata from the internal carotids, which are connected with the circle of Willis, from the vertebral arteries, which unite to form the basilar artery,* and perhaps from other vessels; but it is certain that, if all the arteries given off from the arch of the aorta be tied, the medulla oblongata must be deprived of oxygenated blood.

In Experiment I., the innominate artery and the left subclavian artery were constricted.† and the animal made respiratory efforts in two minutes and eight seconds, notwithstanding that artificial respiration was kept up.

In Experiment II., the same vessels were constricted, and the animal made respiratory efforts in two minutes and five seconds.

In Experiment III., both subclavian arteries and both carotids were constricted, and the animal made respiratory efforts in two minutes and seven seconds. Both vertebral arteries and both carotids were constricted, and the animal made no respiratory efforts for five minutes; but respiratory efforts were made in one minute and thirty-five seconds after both subclavians had been constricted in addition to the vertebrals and carotids.

It seems, from all of these experiments, that, in order to induce respiratory efforts in an animal under the influence of ether and with the lungs supplied with air by artificial respiration, either the innominate artery and the left subclavian artery, or both subclavians, both carotids, and both verbral arteries, must be tied. In other words, according to my views of the cause of these respiratory efforts, the supply of blood to the medulla oblongata cannot be cut off completely except by tying all the vessels given off from the arch of the aorta.

As the result of the experiments which I have just detailed, I must now modify the view which I advanced in 1861 as a conclusion from experiments then published, which I have maintained up to the present time, that the sense of want of air, which is the starting-point of the movements of respiration, is due to want of oxygen in the general system. My experiments made in 1861 were accurate, and the conclusions from them seemed to be legitimate; but these experiments were incomplete. The experiments which I have just reported, taken in connection with my experiments of 1861, lead me to conclude that the sense of want of air is due to a want of circulation of oxygenated blood in the medulla oblongata.

I trust that my experiments, which are by no means difficult, or uncertain in their results, may be repeated and verified or corrected, by other physiologists. The idea that the sense of want of air is due to a deficiency of oxygen in the medulla has been adopted by some writers; but, as far as

* The basilar artery is much longer in the dog than in the human subject.

† In the first experiment, the great veins were also tied, but this seemed to make no difference in the phenomena following constriction of the arteries, and the veins were left free in the other experiments.

I know, my experiments are the first to show, by actual demonstration, that this view is correct.

In another paper, I propose to treat of the respiratory sense much more fully, and to review the literature of the subject. Many interesting and important points will undoubtedly be involved in a full discussion of the nervous mechanism of the respiratory movements, and among them will be the question as to whether the normal respiratory movements be actually reflex in their character, as has been generally supposed, or whether they be due to a direct excitation of the nerve-cells in the respiratory centre.—*New York Medical Journal.*

THE MECHANICS OF VENTILATION.

BY GEO. W. RAFTER, C. E.

(CONTINUED.)

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In order to farther illustrate the theory of ventilation as above set forth, a numerical application will also be made to the Assembly room in the city building of the City of Rochester.

Preliminary data is as follows:

Length =108′ 0″
Breadth= 78′ 0″
Height = 27′ 6″

Floor area, with an addition for stage =8831 square feet.

Total volume, including stage, without deduction for furniture, &c. =244,949 cubic feet.

The seats now in place accommodate comfortably 1,200 people, with standing room for 400 more. Total capacity is therefore taken at 1,600. Deducting one-half cubic foot for each seat, and 3 cubic feet for space actually occupied by each person, and making other deductions for cornices, raised floor at sides and ends, projection of stage into room, etc., and we have an available volume of 230,500 cubic feet.

Under the above conditions the floor area for a single person will be

$$\frac{8831}{1600} = 5.52 \text{ square feet;}$$

while the volume for each person will be

$$\frac{230500}{1600} = 144 \text{ cubic feet.}$$

Lighting apparatus consists of 112 gas burners, each consuming 4 cubic feet of gas per hour. The consumption of gas per hour, then, is $112 \times 4 = 448$ cubic feet.

As previously shown a cubic foot of gas in burning produces 0.43 cubic feet of carbonic acid. Production of carbonic acid per hour from combus-

tion of gas, therefore=448× 0.43=192.6 cubic feet. Each person produces 0.6 cubic feet of the same gas per hour. Production from respiration, then =960 cubic feet. Total amount of carbonic acid per hour=960+192.6= 1152.6 cubic feet.

Assume the heat from a single person to be 475 units per hour, and the heat from combustion of a cubic foot of gas to be 750 units: We have

1600 ×475=760000 heat-units per hour from the audience; and from the lights

448 ×750=336000 heat-units per hour, making a total production per hour of

1096000 heat-units.

Suppose the air supply to be at a temperature of 62° and equal to 2000 cubic feet per hour for each person, the amount per hour will be

1600× 2000=3200000 cubic feet.

The amount of heat required to raise a single cubic foot of air 1° at an original temperature of 60° or thereabouts is

0.0766× 0.238=0.01815 units.

The increase in temperature of the air supply, due to the heat from lights and people will be found as follows:

$$\frac{3200000}{13}=246154 \text{ pounds of air per hour, and}$$

$$\frac{1096000}{246154}=4.4=\text{number of heat-units to each pound of air.}$$

A single heat-unit raises one pound of air through

$$\frac{1.0000}{0.238}=4°.2 \text{ actual temperature.}$$

The increase of actual temperature of the whole supply will therefore be

4.2 ×4.4=18°.48.

On the supposition that the adjustment of supply to exhaust is properly made the air on leaving the hall must have a temperature of

62°+18°.48=80°.48.

The exit per second will equal

$$\frac{3200000}{3600}=888 \text{ cubic feet.}$$

Assuming the velocity of exhaust in vertical flue to equal 20 feet per second, we have for area of said flue

$$\frac{888}{20}=44.4 \text{ square feet,}$$

or what would be preferable, two flues each with area of 22.2 square feet. Assume farther that the inflowing air shall have a velocity of 4 feet per second, the area of inlets will be

$$\frac{888}{4}=222 \text{ square feet.}$$

Assume a sectional area of 6 square feet for each inlet, and

$$\frac{222}{6}=37=\text{number of inlets.}$$

Assume again that velocity in outlets is 6 feet per second,

$$\frac{888}{6}=148 \text{ square feet}=\text{area of outlets.}$$

Also let area of each outlet be 6 square feet, same as inlets

$$\frac{148}{6}=25 \text{ number of outlets.}$$

The discussion has taken no account of the increase in volume due to the increase of temperature. Were such account taken the dimensions of outlets would be somewhat increased.

The number of changes per hour under the above conditions may be determined by two methods, either by dividing the supply per hour for each person by the volume for each person, thus,

$$\frac{2000}{144}=13.9$$

or by dividing the total supply per hour by the total available volume of the hall, thus.

$$\frac{3200000}{230500}=13.9$$

giving the same result in either case.

The discussion has also proceeded upon the supposition of no loss by conduction and radiation. We will now consider the modifications of the above calculations due to these sources of loss.

The hall is warmed by steam, direct radiation. Number of sets of radiators 18, each having an area of 60 square feet. Total radiating surface, therefore,

$$60 \times 18=1080 \text{ square feet.}$$

Amount of space heated by one square foot of surface equals

$$\frac{230500}{1080}=213.4 \text{ cubic feet,}$$

which is certainly ample for the coldest weather likely to be experienced here.

To find loss by conduction through walls and windows, we will assume inside temperature at a mean between temperature of entering air and temperature to which it is raised by heat from persons and lights, or say at 71°. Outside temperature is taken at 32°. The outside exposures are three in number, two sides and one end. We will consider the loss of heat only from the three outside exposures, neglecting the protected end, ceiling and floor.

Area of the three exposed sides exclusive of windows=6306 square feet. Area of windows=1696 square feet.

Taking formula (18) we have for the loss through walls exclusive of windows:

$$a = 6306 \text{ square feet},$$
$$t' = 71°,$$
$$t = 32°,$$
$$k = 0.09\text{ə},$$
$$d = \text{thickness of wall} = 2 \text{ feet},$$

then

$$Q = 0.095 \times 6306 \frac{71-32}{2} = 11487 = \text{number of heat-units conducted away}$$

through walls per hour.

For windows we have

$$a = 1696,$$
$$t' = 71°,$$
$$t = 32°.$$

Experiments have been made in the case of window glass, showing that neglecting d the value of k varies from 1 to 3. We will take it for this calculation at a mean value, namely, 2. We have therefore

$$Q = 2 \times 1696(71-32) = 132288.$$

hence the total loss by conduction per hour under the conditions of temperature assumed is

$$11487 + 132288 = 143775 \text{ heat-units.}$$

Suppose, however, instead of allowing 2000 cubic feet per hour for each person, we take what is more nearly the actual supply, that is 850 cubic feet. With that assumption we have a total supply per hour of 1,360,000 cubic feet. The amount of heat from people and lights will be the same as before. Assume temperature of air supply at 62° as previously. Amount of air in pounds

$$\frac{1360000}{13} = 104615$$

Number of heat-units per pound of air is

$$\frac{1096000}{104615} = 10.4,$$

making an increase of actual temperature of

$$10.4 \times 4.2 = 43°.68.$$

Assuming no loss by conduction and radiation, and the temperature of the outflowing air is

$$62° + 43°.68 = 105°.68.$$

In fact loss by conduction, &c., increases in proportion as inside temperature increases, consequently the amount conducted away will be correspondingly greater than in the preceding case. Observation will show air in upper part of room to range from 85° to 95°. The writer has on several occasions observed it higher than 80° in lower part of room, and this too with windows open, and outside temperature at from 35° to 40°.

A partial exhibit has now been made of the main principles underlying

the Mechanics of Ventilation. In conclusion it will be well to collate principles and facts for convenience of reference.

1. Perfect ventilation is hardly automatic. A certain amount of attention is necessary to keep any system in working order.

2. Ventilation by draught is preferable to ventilation by forcing air in, it having the advantage of supplying fresh air as fast as foul air is removed, provided of course the design is properly carried out.

3. The vacuum may be produced in case of rooms or suites of apartments by fire places or by small flues properly connected with the rooms at or near the floor, in which gas jets are kept burning whenever ventilation is needed. In large buildings, however, the vacuum will of necessity be produced by vertical shafts designed in accordance with the principles herein contained.

Corollary.—Where gas jets are used the amount of heat from one cubic foot of gas may be taken as given in the beginning of this paper. Knowing the amount of air to be carried away per hour, the size and number of burners is easily found.

4. Perfect ventilation will cost something. To lift a thousand pounds of air 50 feet, requires exactly the same expenditure of force as to lift a thousand pounds of iron, or any other substance 50 feet.

Corollary 1.—Since to ventilate a building means there is work to be done, and consequently an expenditure of force necessary, any system professing to ventilate without such expenditure of force can hardly be other than a failure.

Corollary 2.—Careful study of the matter shows the importance of reducing friction in flues, ducts, elbows, etc., to a minimum; otherwise a large percentage of force will be expended for that purpose only.

5. Ventilation is a branch of mathematical investigation, actual construction should, therefore, be preceded by careful calculation.

6. Heating is a branch of ventilation, and should always be considered in connection with it.

Corollary 1.—In warming by heated air the current should be introduced at or near the ceiling. It is a violation of first principles to introduce it near the floor.

Corollary 2.—In designing a system of warming by heated air, provision should be made for introducing cold air in connection with the warm current, in order that the air may not enter the room at too high a temperature.

Corollary 3.—The cold air currents as per Corollary 2 should be under perfect control as well as the heated currents, in order that the proper temperature inside may be maintained under every variation of outside temperature.

Corollary 4.—Warming by steam or hot water, by a combination of the two, or by steam and hot air combined may all be exceedingly healthful, provided adequate ventilation accompanies them. These methods are all reasonably economical as regards consumption of fuel.

Corollary 5.—Warming by ordinary stoves cannot be considered desirable except on the score of economy. The objections to their use are:

(1) Difficulty of producing ventilation in connection with the warming.

(2) Cast iron, the usual material for their manufacture, when red hot allows the gases, carbonic acid and hydrogen to pass through into the rooms.

(3) The heat is irregularly distributed, causing great variations in temperature in different parts of the rooms.

7. It should be understood that ventilation by opening doors and windows is nearly as bad as no ventilation.

8. In large buildings much satisfaction, and what at the present time is of the greatest importance, much valuable information could be obtained by putting up in connection with such a system of ventilation by the vacuum method, apparatus for determining and accurately registering the results under varying conditions of outside and inside temperature. An anemometer in the main shaft with electric recording apparatus in the superintendent's office, would show at any instant exactly the condition of the ventilation. In this way regularity of action will be assured, and at the same time a collection of data of the greatest value in future building operations can be made.—*Van Nostrand's Engineering Magazine.*

THE HYGIENE OF THE HAIR.

Professor Erasmus Wilson, who is probably the highest living authority on the subject, has lately given a course of lectures on the hair before the College of Surgeons in London. They are reported in full in some of the English medical magazines, and an abstract of the more practical portions will doubtless be of interest to many readers of the *Journal.*

Cleanliness is, of course, insisted upon as of prime importance, but washing the hair is emphatically condemned. Brushing is to be preferred, as it promotes circulation, removes scurf, and is in all respects a more effective stimulant than water. Cutting does not encourage growth as much as is commonly believed, but is advantageous in the case of short, slender hairs generally called "young hairs."

Of the countless applications recommended for the cure of baldness, few are ever successful, and in the occasional instances in which they appear to be useful it is possible that sequence is mistaken for consequence, the *post hoc* for the *propter hoc.* Most of the specifics are stimulants, not excepting petroleum, which has lately been eulogized. Croton oil, though excellent as a stimulus, is objectionable on account of the irritation it often causes and which sometimes extends to the eyelids and the face. Cantharides, though milder and more manageable, is likewise liable to give rise to inflammatory congestion and vesication, and sometimes to suppuration and ulceration. The skin may be peculiarly sensitive, or the remedy may have

been employed too energetically, both as to quantity and time. Professor Wilson has seen several instances in which cantharidine has been absorbed into the system and has given rise to ischuria. As a rule, therefore, he rarely uses cantharides, and then always in a guarded manner. Certainly, it is not to be trusted to the acknowledged indiscretion of the public as a popular remedy. Acetic acid, or rather strong pyroligneous acid, he has discontinued for many years; but it is still a favorite, notwithstanding its strong and disagreeable odor.

Ammonia is Professor Wilson's favorite stimulant; it is unlikely to create inflammation and its consequences; it is neither absorbable into the system, nor could it do harm if such were the case; and its odor, refreshing at the moment of its use, speedily evaporates. In a case of ordinary madesia or falling out of the hair, he prescribes a lotion composed of strong liquor ammonia, almond oil, and chloroform, of each one part, diluted with five parts of alcohol or spirits of rosemary, and made fragrant by the addition of a drachm of the essential oil of lemons. The lotion should be dabbed upon the skin of the head after thorough friction with the hair brush. It may be diluted if necessary; it may be applied sparingly or abundantly; and it may be used daily or otherwise.

There are cases in which a less stimulating and even a refrigerating lotion may be desired, and where an objection may be raised to the quantity of oil contained in the above. In such cases a lotion of borax and glycerine, two drachms of each to eight ounces of distilled water, is cooling and refreshing; this lotion allays dryness of the skin, removes scurf, and subdues irritability.

In cases of complete baldness, and also in alopecia areata, a stronger stimulant application will be required. For this he recommends frictions with a liniment composed of equal parts of the liniments of camphor, ammonia, chloroform, and aconite, to be well rubbed into the bare places daily, or even twice a day, so as to produce a moderate amount of stimulation. In cases of ophiasis, due to neuralgia of the cutaneous nerves of the scalp, this liniment is very valuable. In other cases the liniment of iodine may be painted on the bare patches daily, or they may be rubbed with the ointment of cantharides or any other powerful stimulant. The intention of all these local remedies is to stimulate without setting up irritation; to increase the energy of circulation and innervation of the part; and in some instances to abstract the excess of fluids from the tissues of the skin by inducing exudation. But these results must be accomplished as far as possible without pain and without severity.

The constitutional treatment of alopecia should consist in the adjustment and regulation of the functions of digestion and assimilation; and, where no other special conditions are to be fulfilled, the adoption of a tonic regimen and the administration of tonic remedies. Of these last arsenic bears the palm, and may be advantageously prescribed in doses of two to four minims three times a day directly after food, and in any convenient vehicle.

Grayness, canities, or poliothrix depends like baldness on defective powers of the skin, and the indications for treatment are exactly the same, —to strengthen the part and at the same time strengthen the patient. As means of temporarily staining the hair the lecturer mentioned a weak solution of permanganate of potash, a lotion holding in suspension sulphur and acetate of lead, or the so-called *eau des fèes*, consisting of the hyposulphites of lead and soda; among dyes sulphides of various metals, especially silver, the pyrogallate of iron and ferro cyanide of copper. The hair, as is well known, contains sulphur, and a solution of lead brought into contact with sulphur produces a sulphide of lead, which is black in color. Sulphur and acetate of lead in suspension and solution in water supply both the elements necessary for artificial coloration of the hair, and constitute the popular lotions sold so largely.

Actual dyeing of the hair is a more elaborate process: the hair must be washed with soap in the first place, to get rid of grease, which would otherwise interfere with the absorption of the fluid by the hairy tissue; secondly, the hair being dried, the metalic solution is to be employed and left to soak into the hair; and thirdly, the mordant fluid is to be brushed upon the part with a view to bring it in contact with every individual hair. If this operation sufficed for a considerable period, all would be well; but as the hair grows quickly, the newly-grown part exhibits its original whiteness, and another dyeing soon becomes necessary. The tone of color produced by the first application may have been perfect, leaving nothing to be desired, but the white roots of the hair cannot be reached without a fresh coloring over the whole, and then the evils become apparent. A succession of coats of color renders the hair more intensely black than Nature herself could have accomplished, and the harmony of the features of the individual is disturbed; the mellowing of the lineaments of the countenance produced by white hair is reversed by the depth of the blackness, and the features are rendered harsh and severe. The theory that an appearance of youth is maintained by the color of the hair is not consistent with fact, and there is always the danger that the hair may appear youthful, while the features themselves are expressive of old age.

As to danger to the health and constitution from dyeing the hair, Professor Wilson thinks that we cannot reasonably allege the possibility of any serious evils; for lead, to which are imputed the most dangerous of the qualities of hair dyes, enters into the composition of several of our cooling and astringent and sedative lotions, and even injections; and although undoubtedly some cases are on record of damage resulting from its internal use, Goulard's lotion is commonly regarded as one of the most harmless of our remedies. Perhaps a distinction may be drawn between its therapeutical and its cosmetical use, but it is difficult to distinguish the difference. Reference is made to some of the alleged cases of lead poisoning from the use of hair dyes, but it is suggested that a more careful examination might have found the cause elsewhere, perhaps in the water used for drinking.

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It is admitted, however, that there may be cases of peculiar sensibility to the poisonous influences of lead in which these dyes may be injurious. Professor Wilson, as we have said, is high authority on these matters, but we nevertheless advise our readers to avoid all hair dyes containing lead, especially as there are preparations for the purpose that are certainly harmless,—if one is foolish enough to dye the hair at all.—*Boston Journal of Chemistry.*

Plain Directions for Preventing the Spread of Infectious Diseases.

BY J. M. MACLAGAN, M. D.

General Directions.—I. When a case of infectious disease occurs in a house, immediate notice thereof should be given to the Medical Officer of Health or to the Inspector of Nuisances, and medical advice at once procured.

The following precautions should be taken:

1. Isolate the person affected as much as possible from the other inmates of the house.

This is most readily effected by at once removing him to an upper room, if circumstances permit. The room selected should be large and airy, and the means of ventilating it, which shall be presently mentioned, at once adopted.

2. Before removing the patient, the following preparations ought to be made in the room:

All superfluous curtains, carpets, woolen articles, unnecessary clothing—in short, everything likely to retain infection, should be at once removed.

3. The patient's bed ought to be so placed as to allow of a free current of air around it, but not so as to place it in a draught.

4. The room must be kept well ventilated, under the physician's directions, by means either of a fire (when required) or an open fire place and chimney, and of windows opening to the external air. By means of the latter, ventilation is most effectually procured, so as to avoid draughts in the following manner:

Raise the lower sash of the window three or four inches, then procure a piece of wood made to fit accurately into the lower opening, and place it there. By these means free outward and inward currents of air—without causing any draughts—are obtained through the vacant space between the two sashes. When a window is merely opened from the upper and lower sash, draughts are invariably caused.

II. After removal of the patient to the room in which he is to remain, the outside of the door and door-posts should be completely covered by a sheet kept constantly wetted with some disinfecting fluid, such as Burnett's Solution, Condy's Fluid, Carbolic Acid, etc.

2. The room must be kept scrupulously clean. Before being swept, which should be done daily, if possible, the floor should be sprinkled with

Calvert's or McDougall's Disinfecting Powders, or with a weak solution of one of the disinfecting fluids already mentioned.

3. Vessels containing disinfecting fluids should be placed in the room for the reception of all bed and body linen, towels, handkerchiefs, etc., immediately on being removed from the patient, and on no account should they be washed along with other household articles.

4. Disinfectants should also be placed in all the chamber utensils used by the patient, and, after use, more disinfecting fluid should be added, and the whole contents, if possible, should be immediately buried. No chamber vessel should be allowed to remain in the room after having been used.

5. All plates, cups, glasses, etc., which have been used by the patient, should be rinsed with some disinfectant before being washed; and on no account should any vessels used in the sick room be washed along with other things, unless previously thoroughly disinfected.

6. Attendants on the sick should not wear woolen dresses, but only those made of washing materials.

7. Basins containing water, to which some disinfectant has been added, should always be at hand for the benefit of the attendants on the sick, who should not be sparing of their use.

8. No article of food or drink from the sick room should be consumed by other persons.

9. Visitors to the sick room, except in the case of clergymen and medical men, should be peremptorily forbidden: and they, when necessarily present, should, on leaving, wash their hands in water to which a disinfectant has been added, and have as little immediate communication with others as possible.

III. When a death from infectious disease occurs, the body should be at once placed in a coffin and sprinkled with some disinfecting fluid or powder, such as chloride of lime, etc., and buried with the least possible delay.

2. On no account whatever should it be allowed to remain in a room occupied by living persons.

IV. On the termination of a case of infectious disease, either when the patient is pronounced free from infection, or, in the event of death, after removal of the body, the sick room and its contents should be thoroughly cleansed and disinfected.

2. The bed and bed-clothes, and all wearing apparel used by the attendants or patient, should be thoroughly disinfected.

V. In houses where a case of infectious disease occurs, no washing, tailoring, dress making, nor any similar occupation, ought to be carried on.

2. No milk or food of any kind should be supplied from infected houses.

3. Children from infected houses should not be allowed to attend schools, and all persons from infected houses should have as little communication as possible with others, either in private houses or in public places, such as railways, omnibuses, public-houses, churches, etc.

4. Any accumulation of filth or refuse of any kind should be at once

removed from or about the premises, and disinfectants freely used. If this cannot be done by the persons themselves, immediate notice should be given to the Inspector of Nuisances.

5. The existence of nuisances of any kind and wheresoever situated should be at once reported to the Inspector of Nuisances.

VI. During the prevalence of epidemic, infectious or contagious diseases, it becomes specially important that the general laws regarding the preservation of health should be rigidly attended to.

2. Implicit trust should not be placed in so called "disinfectants." They are very useful when judiciously employed, but are by no means certain "preventives of disease."

3. Pure air, pure water, warm clothing and good food should always be obtained if possible. By their constant use less chance is afforded for an invasion of disease.

4. Temperance both in eating and drinking is essential for the maintenance of health and the prevention of disease.

5. Overcrowding in houses, workshops or schools should be strictly prohibited.

6. All houses, cottages, schools and public rooms should be kept clean and well ventilated; and frequent use of lime washing on the walls and ceilings should be made.—*Druggists' Circular.*

METEOROLOGY.

A NEW METHOD OF DETERMINING THE WIND'S VELOCITY.

BY JOHN H. LONG, OLATHE, KANSAS.

A paper read before the Kansas Academy of Science, October 12, 1877.

It having been repeated stated by certain observers in Kansas that the anemometer of the State University registered a higher than probable velocity, I was induced at the suggestion of two gentlemen connected with the institution, to test the correctness of the instrument. The apparatus used by me was very simple, consisting essentially of a hollow copper sphere suspended in front of a graduated horizontal scale. But as a more detailed description may be necessary to the understanding of what follows, I will give it here. Imagine first a perpendicular shaft of iron, eighteen feet long, whose bottom fits into a socket and to whose top is attached a swivel. To this swivel are attached several wires whose other extremities are secured so as to give complete steadiness to the shaft. Other braces are attached for the same purpose, and the swivel on top permits it to turn to suit the

varying direction of the wind. A short distance below the swivel a horizontal arm, fifteen inches in length, is firmly attached to the shaft, and just below this another one is similarly attached. These two arms are equal in length and parallel to each other. To the extremity of the upper arm are fastened two fine iron wires, one, seventeen feet long, supporting a plummet, and the other, six and a half feet long, supporting the copper sphere mentioned above. This sphere is 8.5 centimetres in diameter, and weighs 135.92 grammes. To the extremity of the lower arm is attached the scale, consisting of two lath-like pieces of wood, about four feet long, fastened parallel to each other and about one-half inch apart. Between these, constituting a guide, the wires are suspended, and on the front one the graduation is made. The plumb line serves to determine the zero point, and is of no further use. By means of the swivel above and the socket below, the apparatus is easily turned, so that when the ball is deflected by the wind its vibrations may take place in the space between the two laths. The observation consists in registering the amount of this deflection from the zero point, or point in which the perpendicular line cuts the scale. It is well known that the force of the wind is not constant for any great length of time. It is hence necessary to take a great many observations, at short intervals, in order to obtain a correct mean. In my work I noticed the deflection of the ball through fifteen minutes, making a record every fifteen seconds, which gave me sixty observations for the quarter of an hour. The following table taken from my note book will illustrate:

June 19, 40 m. past 6, def. = 20 cen.	June 19, 41 m. past 6, def = 16 cen.
40¼ " 6, " 18 "	41¼ " 6, " 18 "
40½ " 6, " 20 "	41½ " 6, " 19 "
40¾ " 6, " 17 "	&c.

Cup anemometer marked 15.24 per. h.

I observed always the record of the anemometer for the same fifteen minutes, and at the close of my work, which was continued on several days to obtain mean deflections corresponding to different velocities, I had a number of such records as the above, each consisting of the position of the ball at sixty different periods.

By a well known principle of mechanics I found the force or *pressure* of the wind necessary to produce in the ball of known weight the observed deflections, and for convenience made the following table:

For deflection of	1	centimetre,	force =	.73	gramme.
"	"	" 2	"	"	1.46 grammes.
"	"	" 3	"	"	2.19 "
"	"	" 4	"	"	2.92 "
*	*	*	*	*	*
"	"	"60	"	"	43.8 "

Having this table of pressure, the next question is to find the wind's velocity corresponding to each of them. There are several empirical formulas, which might be applied to the solution of a problem such as this, but one proposed by Weisbach seems to be the most reliable. It is for the action of an unlimited stream, either of water or air, and by giving suitable values to some of its factors it affords an easy solution to the problem in

hand. I do not know that it has ever before been applied in this way, but I find the results obtained agree very closely with those derived from a formula computed by Colonel James for the British Board of Trade. The formula is this:

$$P = z \frac{v^2}{2g} Fy,$$

in which P is the pressure of the wind, z a term dependent on the shape of the body exposed to the wind, $\frac{v^2}{2g}$ the height due to the velocity v, F the exposed area, y the density of the air. The value of z has been found from experiment to be about 0.64, so transposing the equation to find the value of v^2 we have,

$$v^2 = \frac{2g\ P}{.64\ Fy},$$

from which the numerical value of v can be easily found, as those of g, P, F and z are known. It must be observed that the value of z varies with the barometric height, making it necessary to read the barometer for each set of observations. It is now easy to construct another table, as follows:

For deflection of			1 cen.,	velocity	=	3.9	m.	per	h.
"	"		2 "	"		5.51 "		"	
"	"		3 "	"		6.74 "		"	
"	"		4 "	"		7.80 "		"	
*	*		*	*	*		*		
"	"		60 "	"		30 2 "		"	

Finally these values are substituted in the columns of deflections observed, and a mean obtained which represents the wind's velocity for the fifteen minutes of observation.

After making a large number of experiments as above described, I learned these facts regarding the anemometer at the Kansas University: First, that it never registers too much, and second, that for small velocities it does not register enough. This is due to the fact that a gentle wind, whose strength, however, is sufficient to deflect the ball, will fail to move the cups sometimes for many minutes.

The following figures will show results obtained by both methods. The first column contains the velocities determined by the deflected ball, and the second those determined for the same time by the anemometer:

5.6	m	per h.	.64	m.	per h.	15.3	m.	per h.	15.	m.	per h.
10.5	"	"	4.84	"	"	15 6	"	"	14.88	"	"
11.68	"	"	10.62	"	"	17 5	"	"	16.	"	"
13.5	"	"	10 89	"	"	18.2	"	"	18.15	"	"
13 7	"	"	12.81	"	"	18 7	"	"	18 39	"	"
14.7	"	"	14.5	"	"	20.	"	"	19.2	"	"
15.	"	"	14.5	"	"	25.3	"	"	25.14	"	"

It will be observed that for medium and high velocities the two methods compared very well, and for low velocities, as intimated, the anemometer fails to give a large enough record. Besides showing that the apparatus at Lawrence cannot register too much, my observations have convinced

me that the method is one which may be of value to meteorologists. From extreme simplicity and lightness, the instrument may be easily carried from place to place by traveling observers, and a record of the wind's velocity at any station can be obtained in a few minutes. As a check upon another instrument it may be used to advantage as just shown. The dimensions which I have given are larger than necessary. I chose them in order to have the copper ball on a level with the cups of the anemometer.—*Kansas Collegiate.*

METEOROLOGICAL—ABSTRACT FOR OCTOBER, 1877.

BY PROF. WM. K. KEDZIE.

Condensed from the records of the Kansas State Agricultural College. Lat. 39° 12′; long. 96° 40′. Height, 1,200 feet.

THERMOMETER.

Mean temperature, 53°.37, which is .24 of a degree above the mean for October for 14 years. Maximum temperature on 2d, 80°. Minimum temperature on 3d and 20th, 27°.

BAROMETER.

Mean height, 28.76 inches. Maximum height, 10th, 29.05. Minimum height, 28th, 28.39.

RAIN.

Total rain-fall for the month 207 inches; the greatest fall ever measured at this station, and 7.28 inches above the average for October for 14 years. Rain fell on 12 days.

CLOUDS.

Per cent. of cloudiness: 7 A. M., 70; 2 P. M., 71; 9 P. M., 58; mean, 66. Entirely cloudy days, 14; partly cloudy, 17; entirely clear, none. Heavy fog on 26th.

WINDS.

Northwest, 10 times; north, 2; northeast, 22; southwest, 27; southeast, 6; calm, 26.

OZONE.

Day—Maximum, 6; mean, 2.89.
Night—Maximum, 9; mean, 2.85.

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FOREIGN CORRESPONDENCE.

PARIS, October 27, 1877.

Since the commencement of the present century, one-fifth nearly—18 per cent. of the death-rate of Paris, is represented by consumption. It is the most cruel of diseases, devouring the young and productive part of the nation, like a Cretan Minotaur. Dr. Lagneau, one of the highest authorities on phthisical maladies, attributes consumption to impure air and insufficient bodily exercise. It is a disease rather of race than of the individual; it is ubiquitous, not peculiar to any climate, still less to any condition; it is the associate of misery, as well as of wealth. Dr. Lagneau does not find a remedy for this scourge in change of climate or of scene; on the contrary, he is not averse to thinking, that the prevailing taste for cosmopolitanism, for "peregrinomania," as Guy-Patin designated the modern rage for going to and fro, is no stranger to an aggravation of an aggravation of the endemic. The sudden changing of officials, from the north to the south of France, and *vice versa*, contributes to the production of consumption. In Paris, the native is less subject to consumption than the immigrant part of the population; and more males perish by that disease than females. There are persons who flock to the shores of the Mediterranean to be cured of phthisis; but the climate does not prevent the ordinary inhabitants from paying their quota to the universal disease. Elevated regions, as the Alps, the Pyrenees, the Andes, the plateau of Mexico, Iceland and Norway, possess a certain immunity against consumption; but cold is not the preventive agent, since the disease exists in Christiansand, and is no stranger to Greenland. In the north of France the exemptions of young men from military service, on account of lung disease, is greater than in the southern part of the country. Misery and inefficient food do not account for the cause of consumption. In the department of the Nord, where the highest wages and best living are enjoyed, the death rate for pulmonary complaints is higher than in the department of the Morbihan, where salaries are lowest, and nourishment the worst in all France. If the disease strikes the extremes of social life, as the doctor maintains, nearly equally, there can be no doubt that insufficient sustenance must be a preponderating influence, if not in the production, at least in the development of the germ of the terrible affection. Less controversial are the doctor's recommendations to prevent consumption; these are summarily: the constant changing of air in apartments; good bodily exercise; moderation in living; avoidance of idle habits, and of a too sedentary life. Jewelers, lace-makers, tailors, and shoe-makers, are most subject to phthisis, as also soldiers leading a barrack instead of a camp life: confinement is here the predisposing agency. On the other hand, millers, wool-combers, barbers,

&c., have an equal tendency to consumption, owing to the detritus constantly floating in the atmosphere where they work. Work-shops ought to be, according to Dr. Lagneau, subjected to as severe surveillance as lodging houses and hospitals, to prevent over-crowding; all access should be given, not only to air, but to light, and in schools as much importance ought to be devoted to gymnastics, as to intellectual pursuits, and more time for recreation. Singing societies ought to be established in country towns, and every effort made to encourage manly exercises and healthful amusements, to wean provincials from their tendency to come and live in cities—those "gulfs of humanity," as J. J. Rosseau designated them.

The air is fourteen and a half times heavier than hydrogen gas—the latter being the lightest of all known bodies, hence, why it is selected for filling balloons. In practice, however, pure hydrogen is superceded by coal gas on account of its greater cheapness, and because it is always ready prepared. But coal gas is heavier than hydrogen, so that the economical preparation of the latter, is an important matter for æronauts. One of the wonders of next year's exhibition will be a monster balloon by M. Giffard, cubing 20,000 yards; it will be filled with pure hydrogen; during the summer he has been experimenting how to produce pure hydrogen not only cheaply, but in large quantities; he has employed two furnaces, of fire-proof clay; the lower one filled with coke, the upper with fragments of natural oxide of iron. The coke being incandescent, the oxide of carbon generated, is conveyed by tubing, over the oxide of iron; the latter yields its portion of oxygen to the oxide of carbon, and thus forms carbonic acid which escapes into the air; the iron remains pure. Through the latter a jet of steam is passed; the iron seizes the oxygen of the vapor, and the hydrogen, that other element of water, passes into a refrigerator, and is dried over a bed of chalk. M. Giffard prefers rather the old process for obtaining hydrogen: he lines a boiler with lead, on which sulphuric acid, in the cold state, has no action; the bottom of the boiler is double, one being perforated, and through which a solution of the acid is introduced to act upon iron clippings; hydrogen is thus produced in great abundance; the sulphate of iron, hitherto an obstacle, is run off into a reservoir. It is this "wet process" of producing hydrogen that will be employed to inflate the giant balloon next year.

The project of creating a sea in the interior of Algeria, may be considered as abandoned; after being weighed in the balances by the Academy of Sciences, it has been found wanting. But this does not the less redound to the credit of Captain Roudaire, who has sacrificed his health and fortune to the survey of the projected canal of some 110 miles, to flood the desert, and make the Sahara blossom like the rose. He has also had the warm support of M. de Lesseps in the feasibility of the scheme. The region to be operated upon is the sandy waste situated some 125 miles south of Tu-

nis; in ancient times this region was occupied by comfortable and commercial populations; to-day it is a series of dried up salt lakes, but which formerly communicated with the Mediterranean, by a strait at the depth of the Gulf of Gabes. These communications have been choked up with sand, so that what was once an active centre of navigation is a desert now, where not a trace of former civilization can be found. According to Roudaire, the area to be flooded is 10,600 square miles, to be fed by a canal 110 miles long; the estimate for the main and lateral canals is about fr. 1,400 millions. It was urged, that an immense evaporation, 39 million cubic yards during 24 hours, and double during the period of the sirocco, or equal in total volume to the quantity of water which flows in the Rhone at Lyons would occur. Now the current produced by this evaporation would so erode the banks of the canal, that the channel would silt up, and finish by being choked with sand. It was also alleged, that the evaporation of the water in the inland sea, would leave such a deposit of salt, as to make it poisonous for fish, and finally, it was more likely the rain calculated to fall from the great evaporation, would take place, not on the desert as was expected, but on the shores of the Mediterranean and the neighboring mountains.

Which is the most contagious, measles or scarlatina? These two eruptive fevers hold the first rank in being transmitted, not only by actual contact but by vicinity, the breathing of a common air or the usage of common objects. Not to mention vehicles, the leaves of a book read by a convalescent preserve the contagious principle; the folds of a garment also transport it as in the case of Hildenbrand, who brought scarlatina from Vienna to Podolia, where the disease had never been known, in an infected coat that he had never worn since eighteen months. Dr. Dumas dissents from the general opinion, that scarlatina is more pre-eminently contagious than measles; the latter malady attacks in a wholesale manner, scarlatina strikes discreetly, is eclectic, often picking out in the same family one child and sparing the rest, the parents almost habitually escaping. Contagion by measles is mostly contracted when the disease is in full eruption, or when on the decline; in scarlatina it is more uncertain, but is generally late. The question is asked, When will a Jenner appear to vaccinate for the measles and scarlatina?

M. Dransert draws attention to the singular oscillation of the eyeballs, which in some individuals suffering from the affection, move from 50 to 100 times per minute, with a rythmical regularity from one angle of the eye to the other, or from downwards upwards. This perpetual motion of the eyeballs is attributable to the fatigue of the muscles, and in the case of the Auzin miners, is the consequence of their habit of looking upwards when at their work; an excessive action of the muscles is thus produced, a kind of spasm; the afflicted when he walks, generally has the head thrown back, to relieve instinctively the muscles destined to raise the eye. Intemper-

ance augments the infirmity, especially the day succeeding drinking. The ungraceful movement of the eyes of Albinos, M. Dransart believes, is to be attributed to a poverty of blood, and he connects them with miners, who are subject to anæmia.

All is not yet cleared up as to the physiological role of the spleen; it is now generally supposed to take an active part in the constitution of the blood, serving too as a kind of reservoir; it also belongs to that class of glands which do not pour their secretions outside of their organs. It can be removed from the system without producing any fatal consequences; dogs experience no difference in point of health when their spleen is extracted, and the operation, it is stated, promotes the fattening of stock destined for the butcher. Dogs thus operated upon die very suddenly, and apparently from no specific cause. Once removed, the spleen cannot be reproduced; salamanders can replace some organs if destroyed. M. Schiff, states that in the case of animals whose spleen has been removed, the white predominates over the red globules of blood, as in the the case of poverty of the latter. He also observed the spleen when experimenting on dogs, secreting a special ferment which, mixing with the pancreatic juice, imparted marked aid to the process of digestion.

Boiler explosions are frequent, owing to incrustations forming on the plates. M. Heret, a well known chemist, has employed lime-water to fix or neutralize the fatty acids introduced by the steam from the greasing of the cylindrical boxes; these form a kind of soap in the water destined to feed the boilers. These fatty acids attack the sides of the boiler, producing enormous crusts of black soapy, ferruginous matter; these isolate the metal from the water, and hence it becomes dangerously heated. By passing a solution of lime into the feed water, the calcarous soap becomes insoluble, and the glycerine rendered free exercises no action on the metal. The process has been now adopted in the French navy.

It has been defined, that man is the only animal which laughs; Graves has stated he is the only animal that cooks, and indeed humanity may be said to be divided into two epochs, that preceding, and following, the discovery of cookery. Pre-historic man, resembled savages of the present day, whether on the continent of America, in Australia, or Polynesia, where fish, animals, and loathsome insects are eaten raw, as a kind of change from fruits. Man was not as some *savants* allege, originally a vegetarian; the latter is perhaps an artificial kind of alimentation. Brahmins only became frugiferous when agriculture put within their reach that kind of food. Vegetables are easily consumed by birds and cattle, because they have gizzards and paunches—appropriate organs, but wanting to man; hence, the necessity of the culinary art to make rice and millet digestible. But to cook, it was essential to have fire, and for a long time humanity was

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deprived of this element. Indeed it was even a marketable commodity, and some tribes still carry living embers, as they camp. Fire was perhaps originally produced, as Indians still practise, by rubbing a pointed stick in a hole in wood. It appears clear, that fire was known to man, when he was contemporaneous with the mammoth, but the earliest traces of cooking utensils date from his association with the cavern bear and reindeer. A pot represents a certain civilization; often the animals were cooked in their own skins, as ostriches still are; or a hole was dug in the ground, coated with clay, filled with water, into which heated stones were plunged. Punch is thus warmed in some parts of Germany, and it was formerly a favorite plan in Ireland, to boil milk. It was woman who was in early times trusted to make the earthen pots, then to employ them, and finally to guard them, and hence, to be queen of the fire side.

Professor Ecker, of Fribourg, concludes, that the greater length of the index, over the ring finger, is a proof of physical perfection and evidence of superiority of race. F. C.

SCIENTIFIC MISCELLANY.

WONDERFUL DISCOVERIES IN THE SANDSTONE ROCKS OF COLORADO.

"Nature has borne strange children in her day," says Shakspeare, and he is not far wrong, if we may judge from some recent discoveries in the rocks of our neighborhood. While exploring some rocks in the white sandstone hog-back of the cretaceous period, near Morrison, Bear Creek — the same stratum as at Colorado Springs, a few yards west of old Colorado City —we came suddenly upon a huge vertebra, lying as if it were carved out in bas relief on a slab of sandstone. It was so heavy that it required two men to lift it. Its circumference was thirty-three inches. We stood for some moments looking in astonishment at this prodigy, and then hunted around for more relics. Presently one of the party, a little in advance, cried out, "Why, this beats all!" At his feet lay a huge bone, resembling a Hercules war-club, ten inches in diameter by two feet long. On digging beneath it, a number of smaller vertebræ were discovered, and at the base of a cliff two enormous fragments, reminding one of the broken columns of some ancient temple, or a couple of saw-logs, lay on the ground, possibly thigh bones, fifteen inches in diameter at the butt end; and in the cliff above them was another fragment sticking out of the rock like the stump of a tree. With the help of a sledge-hammer and crowbar, the rock was

removed around it, and underneath lay some ribs three inches in diameter, with other bones.

The rocks in the vicinity were full of fragments. Selecting one of these, we lifted off a large cap of sandstone above it and disclosed a perfect shoulder, ulna and radius, of another somewhat smaller animal, the thickness of the bones averaging about five or six inches. This, lying as it was like a beautiful sculpture on the sandstone, we succeeded in removing exactly as we found it. Several smaller bones of animals of various sizes were discovered. We succeeded in dragging our prizes, on a temporary sled, down the cliff to the road, and bringing home to the neighboring village a wagon load of bones and depositing them in a shanty, preparatory to packing them off East to Prof. Marsh, of Yale College, for identification. The monster to whom the bones belonged could not have been less than sixty or even eighty feet long.

Along the shores of this ancient sea squatted and leapt the dinosaurus or the terrible lizards, one of whom (the lælaps) was 24 feet long. From the length of his hinder legs, it is supposed that he was able to walk upright like a biped, carrying his head 12 feet in the air. There was another still larger, 35 feet long, and of the same habits. In the air overhead, huge bat-like creatures (Pterodactyls), combining a lizard, a crocodile, and a bat, flapped their feathery wings (25 feet from tip to tip) over the sea, plunging every now and then into the water for a fish. There were birds, too; a diver (Hesperornis) five and one-half feet high, and some, strange to say, with spinal vertebræ like a fish and armed with pointed teeth in both jaws. Enormous tortoises and turtles were the boatmen of the age. One discovered by Cope, in Kansas, was fifteen feet across the end of one flapper to the end of the other. Huge clams also lay scattered over those ancient shores, twenty-six inches in diameter. Our saurian did not fall short of the biggest of these monsters; he could not have been less than sixty or seventy feet long, and probably either a Mosasaurus or lizard, allied to the Elasmosaurus.

The ocean in which these creatures lived was gradually enclosed by the upheaval of the sea bottom on the west, and soon became almost an inland sea. As the elevator continued and its area was contracted, ridges would rise, insolating portions of the sea into salt lakes and imprisoning the life in them. The stronger soon destroyed the weaker, till the water, by evaporation, becoming shallower, all life finally died, became skeletons, and, in course of ages, fossils in sandstone.—*Colorado Springs Gazette.*

ANOTHER SEA SERPENT.

On the 2d of June last the royal yacht Osborne, while cruising off the coast of Sicily, encountered what was supposed to be by many on board the veritable sea serpent. According to Lieutenant Haynes, his attention was first attracted, in a perfectly smooth sea, by seeing a ridge of fins above

the surface of the water, extending about thirty feet, and varying from five to six feet in height. On inspecting it by means of a telescope, at about one and a half cable's distance, he saw a head, two flippers, and about thirty feet of an animal's shoulder. The head, as nearly as he could judge, was about six feet thick, the neck narrower, about four to five feet, the shoulder about fifteen feet across, and the flippers each about fifteen feet in length. The movements of the flippers were those of a turtle, and the animal resembled a huge seal, the resemblance being strongest about the back of the head. He could not see the length of the body, but judged it to be about fifty feet. The tail end was invisible, unless the ridge of fins which first attracted his attention, and which had disappeared by the time he had got the telescope, were really the continuation of the shoulders to the end of the object's body.

The head was not always above water, but was thrown upward for a few seconds at a time, then disappearing. There was, however, no blowing nor spouting.

This account was substantially confirmed by the statement of the engineer and of others on board. The captain distinctly saw the seal-shaped head, the immense size of the flippers, and a part of the body.

These reports were considered to be of so much interest that the Admiralty thought proper to refer them to the criticism of scientific men as to the probable nature of the apparition, and the matter was placed in the hands of Mr. Frank Buckland for the purpose, who presented the subject for consideration to Prof. Owen, Mr. A. D. Bartlett, of the Zoological Garden, Captain David Gray, and Mr. Henry Lee, and in a recent number of *Land and Water* he publishes the responses of these gentlemen.

Professor Owen does not think there is any ground for supposing this to have been an animal unknown to naturalists, but considers it probably referable to some unusual movements of one or more marine animals, either cetaceans or fishes. He, however, is entirely non-committal on the subject, beyond refusing to assent to the existence of any unknown monster.

Mr. Buckland suggests that the phenomena may have been caused by the procession of several basking-sharks, which are of sufficient magnitude to have produced at least some of the appearances.

Captain David Gray thinks that in all probability the phenomenon was produced by several small whales moving together, the look of the head and shoulders in the sketch furnished by the officers of the Osborne being quite similar to that of a whale when moving from the spectator. The appearance of the fins, which could not have come from any single whale, might possibly have been produced by a combination of several animals.

Mr. Bartlett, on the other hand, thinks it possible, perhaps probable, that the animal seen by those on board the Osborne may have been a marine reptile analogous to some of the gigantic saurians known to geologists, such as the ichthyosaurus. As illustrating the possibility of the existence of monster animals for a long time unknown to man, he cites the

case of the hairy-eared, two-horned rhinocerous, caught at Chittagong some years ago—a species previously entirely unknown to naturalists, although the region inhabited by it was supposed to be thoroughly explored.

Mr. Henry Lee coincides in opinion with Mr. Bartlett as to the existence of an undescribed species, and thinks that the phenomena are not to be explained by the movements of any known species, the fact of there being no blowing nor spouting warranting the conclusion that it is not a cetacean. —*Harper's Weekly.*

A Group of Fossil Lizards.—Entering the parterre saloon of the Royal Cabinet of Natural Curiosities, containing a geognostic collection of articles found in Wirtemberg, you will observe on the right hand a group of a rare character, covered by glass. They are twenty-four fossil lizards in sandstone, which, by most skillful hands, carefully prepared, does now belong to the institution. It obtained the group within the few last years, and but recently it was exhibited to public view. The animals lie on 1.5 square meters of fine sand, just as they were formed, just as death had befallen each of them, ages ago, and as the water drove their cadavers together. They lie over and beside each other, one of them completely preserved from the snout to the tail, while another is in a state of mortification, with pieces of shell and bones scattered here and there. Here we see one on its belly, there one on its back, and here again on the side, just as chance had placed the bodies—just as the sand or mud had buried and covered them for thousands of years. They cannot be compared to any now living lizards; they are as little like the now living crocodilian as they are like the now existing saurian. They seem rather to be a union of types, which, in later development, took different directions into special classes and orders. Their most essential part is the form of the head, properly to be called a bird's head; the character of the bones of their extremities as we find them in a class of lizards having a strong scaly mail, consisting of some sixty to seventy mail rings. The mediocre size of the full grown animal is eighty-centimeter. The group is altogether single in its character, and no museum of the world can exhibit a parallel case.—*Translated for the Globe-Democrat.*

The Fortunes of the Obelisks.—The sister obelisk to Cleopatra's Needle has been presented by the Khedive of Egypt to New York city. As we noted last week, it was proposed to defray the expense of transportation across the Atlantic by public subscription, but this course has since been rendered unnecessary by the magnificent offer of a well known citizen, whose name is as yet withheld, to bear all the expense, amounting to $100,000, himself. This proposal has been accepted, and we understand from the New York *World* that the contracts for the removal and shipment of the stone have been signed. At present the question is being discussed where the obelisk is to be erected when we get it; and opinion seems to be

about equally divided in favor of establishing it in the centre of Madison Square, between Twenty-third and Twenty-fifth streets, on Fifth Avenue, or in the park into which it is proposed the site of the present distributing reservoir on Forty-second street and the same avenue shall be converted, after demolition of the now unnecessary reservoir.

In view of the distribution of Egyptian obelisks over the surface of the earth, one being in Rome, another in Paris, another in London, and now another in New York, it has been humorously suggested that the archæologist of a dozen centuries hence will be vastly puzzled to account for the wonderfully wide contemporaneous dispersion of the Egyptian race, which will be indicated by the localities of its monuments.—*Scientific American.*

PURE WATER.—The Board of Water Commissioners—Messrs. Brown, Walsh and Sweeny—met Wednesday afternoon at the Waterworks, for the purpose of testing the efficacy of a new filtering apparatus designed for the purification of water used by cities. A model of the arrangement was brought to St. Louis, on Tuesday last, under the charge of Mr. F. M. Mahan, of St. Joseph, one of the owners of the patent, and President of the Novelty Manufacturing Works, of that city.

The process used is an exceedingly simple one, and as Mr. Mahan remarked, it is a wonder that somebody had not thought of it before. It consists of sinking a bottomless box or float into the river, the high sides of the float quieting the disturbed waters inclosed, and, being quieted, the sediment of course settles to the bottom of the river. Within this quieting chamber is another sort of bottomless apartment, into which the water rises, and from here the water percolates through tubes filled with sand and covered at each end with perforated tin, into the receiving chamber. In a word, the water is by this process first settled and then purified by its passage through the tubes of sand, flowing into the tubes in its endeavor to find its own level.

The model used yesterday was made of tin, about half as long as a common skiff, though much higher. The trial was made off a raft lying on the river near the works, at a place where the water was unusually muddy. The float was put overboard at 3:30, and in seventeen minutes the five-gallon receiving chamber was full of water, perfectly clear from sediment or suspicion of color. The members of the Board tasted it, compared it with the element which now and then overflowed the raft on which they were standing, and seemed well satisfied that the apparatus could filter even the tawny Missouri.

The amount of water used daily by the city is 28,000,000 of gallons, and this is settled after a fashion in the wells made for that purpose. Mr. Mahan claims that one of his floats three hundred by one hundred feet, fitted up with lines of sand tubes, will be able to filter 30,000,000 gallons daily, from which supply water clear as crystal can be forced all over the city.—*Globe-Democrat.*

VALUABLE IMPROVEMENT IN LEAD FURNACES.—An improvement in lead furnaces, the invention of Mr. John B. McCurdy, is creating quite a stir in Joplin. The nature of the improvement is confined principally to the manner of introducing the blast to the charge in the Scotch hearth furnace. Instead of directing the blast through one or more circular orifices or "eyes," (the furnace of Mr. McCurdy, which is in full operation in the smelting establishment of the West Joplin Lead and Zinc Company), the furnace back is so cast as to contain just above the usual metal well, a thin, continuous air-slit which extends around three sides of the charge. The action of the blast is modified at the point of greatest convergence by an expansion of the air-slit at the points whereat the pressure is most indirect. The result of the combination of this improved form of blast with the Water Jacket back, is in the surprising increase in the quantity of lead smelted daily, and the remarkably large percentage of lead from the ore. When the patent is obtained we will illustrate this invention with a first-class engraving. Result of test runs on McCurdy's new water back:

Name of Smelter.	Mineral Smelted.	Lead Made.	No. Pigs.	Per cent.
Brewer & Cummings	3,000	2,315	27	77 1-6
" "	3 000	2,220	26	74
Lloyd & Workizer	3,000	2,315	27	77 1-6
Hains & Haugh	3,000	2,320	27	77 1-3
	12,000	9,170	107	76 5-12

ANCIENT PERFUMERY.—M. Jules Simon traces back the origin of perfumes to the early times of the Chinese Empire, and mentions a curious habit which prevailed amongst the fine ladies of the Celestial Empire of rubbing in their hands a round ball made of a mixture of amber, musk, and sweet-scented flowers. The Jews, who were also devoted to sweet scents, used them in their sacrifices, and also to annoint themselves before their repasts. As for the Scythian women, they went even a step farther, and, after pounding on a stone, cedar, cypress and incense, made up the ingredients thus obtained into a thick paste, with which they smeared their faces and limbs. The composition emitted for a time a pleasing odor, and on the following day gave to the skin a soft and shining appearance. The Greeks, as a matter of course, obtained their knowledge of perfumes from the gods. It was betrayed to them by Œnone, one of the attendants of Venus. They made such use of the invention as ought to have caused them to be very grateful to the indiscret nymph. They carried sachets of scent in their dresses, and filled their dining-rooms with fumes of incense. Even their wines were often impregnated with decoctions of flowers, or with sweet-scented flowers themselves, such as roses and violets. There were also appropriate scents for each limb, and even each feature, and the elegants of Athens resorted to such effeminate refinements of luxury in this matter as might well be ridiculed by Virgil in the lines which he puts into the mouth of Turnus. One of these refinements consisted in annointing pigeons with a liquid per-

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fume and causing them to fly loose about a room, scattering the drops from their feathers over the heads and garments of those who were feasting beneath. Besides the luxury of mere adornment, there were most important duties reserved for certain scents. The essence of quince was given as a preservative against dyspepsia and lethargy, the odor extracted from vine leaves for clearing the brain, and that of white violets to promote digestion.—*Journal Applied Science.*

CEMENT FOR FASTENING KNIVES AND FORKS INTO THEIR HANDLES.—Take one pound rosin and half pound of powdered sulphur; melt together, and mix in about twelve ounces of fine sand or powdered brick. Fill the cavity of the handle with this mixture, melted. Make the shank of the knife or fork quite warm and insert in place and let it remain until cold. when it will be found to be firmly fixed. The handles of knives and forks should not be put in hot water.

A SUBSCRIBER says a pen scratches because the inside corners wear off, and look like the bottom of a M. To restore it, rub the end square and even on a whetstone. Bring the slope of the nib to a point to suit you. Then, holding the pen nearly upright, roll it around, holding the nib on the stone to make the point round. Make it as round and smooth as you can.

MINERAL OIL FUEL.—The neighborhood of the naphtha springs of Bakou has suggested the idea of using mineral oil as fuel for the Ruasian flotilla stationed in the Caspian. Three vessels are already heated by this means; and the result has proved so satisfactory that the boilers of four other vessels are being altered to adapt them to the new system.

BOOK REVIEWS.

PRE-HISTORIC RACES OF THE UNITED STATES OF AMERICA; by J. W. Foster, LL. D. Fourth edition. Chicago, S. C. Griggs & Co.; London, Trübner & Co. pp 416 octavo, $3.00. For sale by Matt. Foster & Co., Kansas City.

The subject of anthropology has interested scientific men for centuries, but it is scarcely a half century since they began to question the literal correctness of the history and traditions which assign to man an antiquity exceeding the six thousand years of Biblical story. It is probable that the investigations of travelers among the Asiatic races convinced them that this period was entirely too short for the rise, development and decay of their systems of civilization, and that broke the ice for and impelled

the numerous and profound researches which have been made in recent times into the history of the human race in the remoter ages.

The result of these researches seems to be that man's history began at least with the animals of the Quaternary, if not with these of the Tertiary period, and that he has gradually risen from a savage being to the degree of intelligence he now manifests.

The French geologists and archæolgists have, perhaps, more than those of any other country, devoted themselves to the study of anthropology, and it is to the early researches of such men as Bouè, Cuvier, Tournal, Christol, Boucher de Perthes and Lartet that the world is indebted for the knowedge of pre historic man which it now possesses, for while many of the scientific men of England and Germany soon took up the question and joined in the investigation of the subject with great zeal and industry and ultimately, perhaps, even surpassed the French in the extent and value of their discoveries, still the chief credit for the conception and inauguration of the work must be given to the former.

In England Kemp, Frere and Dr. Buckland were among the earliest writers who advocated the high antiquity of the human species, while later Sir Charles Lyell, Milne Edwards, Sir John Lubbock and others have added the weight of their opinions to the same side of the question.

Numerous works have been written upon the pre-historic races of different portions of the world and all possess the greatest interest to readers of almost every class, but none that we have ever seen surpasses and scarcely any equals that of Col. Foster.

From his wide experience as an explorer of the physical geography of the Mississippi Valley and the Lake region, and as an investigator of and a writer upon ethnology and its kindred subjects, he was admirably fitted to prepare a work of this kind, based as it is largely upon his own personal observations, and it will certainly be the decision of every reader of this book that he has been remarkably successful in conveying accurate, scientific information and learning in a clear, easy and popular style, thus making the subject attractive and interesting to all classes of readers and the work especially valuable to the student of anthropology and archæology.

Two chapters are devoted to the antiquity of man, in the first of which the progress of discovery of its evidences in Europe is set forth, and in the second that of the United States is recorded. In the third chapter the mound builders and the geographical distribution of their works are considered, and in this chapter are described the wonderful earthworks and mounds at Marietta and Newark, Ohio, Cahokia, Ills., and St. Louis and Charleston, Mo., all of which we have personally examined, and in addition those of the whole Mississippi Valley, New Mexico, Colorado and the Atlantic and Pacific coasts.

Chapter IV is devoted to Shell mounds and their geographical distribution; Chapter V to mounds and enclosures; Chapter VI to Mound builders and their arts and manufactures; Chapter VII to Ancient mining by the

mound builders; Chapter VIII to the Crania of the mound builders; Chapter IX to Manners and customs as a basis of ethnic relations; Chapter X to the solution of the question, Who were the mound builders?; Chapter XI to the Unity of the human race, and Chapter XII to Chronometic measurements as applied to the antiquity of man; thus going over the whole subject in a systematic, comprehensive and philosophic manner, which is equally as satisfactory to the reader as it is demonstrative of the author's erudition and ability.

No one will lay the work down without feeling amply repaid for reading it, whether considered as a mere work of scholarship or as a compendium of information upon the topics discussed.

The mechanical execution of the work is first class and is fully equal in paper, printing and binding to anything from the older publishing houses of the East.—[ED.

INTRODUCTION AND SUCCESSION OF VERTEBRATE LIFE IN AMERICA, an Address before the American Association for the Advancement of Science, at Nashville, Tenn., August 30, 1877, by Prof. O. C. MARSH, Yale College, pp. 57.

This is one of the most interesting papers we have ever read and we give below an imperfect summary of it.

Starting out with the proposition that "to doubt evolution is to doubt science, which is but another name for truth," Prof. Marsh gives in detail the evolutionists' explanation and exposition of the origin, rise and development of animal and vegetable life on the earth from its earliest dawn in the Palæozoic age down to the triassic period in which appear the first and lowest forms of mammalia; thence he laboriously and carefully traces step by step the development of the mammalian tribes, beginning with a single small Marsupial found in the Trias, followed by the Edentates, the Cetaceans, the Sirenians, the Ungulates, Rodents, the Insectivores, the Carnivores, and culminating in the Primates, composed of Lemurs, Apes and *Man*.

The differences between the fossil vertebrate life of America and that of Europe seems to consist principally in the fact that it did not appear in the former during the Archæan, Cambrian or Silurian periods, although during this time more than half of the thickness of American stratified rocks were deposited; that the Devonian fishes of America were less numerous but larger than those of Europe; that in the great inland cretaceous sea of North America the true osseous fishes were most abundant and the most perfectly developed. The American Amphibians were all of moderate size as far as their osseous remains have been found, but the foot-prints left by some whose remains have not been discovered indicate animals larger than any of the class yet found in the old world. There is no evidence of Reptiles in America in any rocks older than the Carboniferous, while true reptiles have been found in the Permian rocks. A striking feature of the

American cretaceous fauna, as contrasted with that of Europe, is the almost entire absence in our strata of species of Ichthyosaurus and Plesiosaurus which abound in many other regions, but we far surpass them in Mesosauria and Dinosauria. The American Pterodactyles, also, differed from those of Europe in being larger and having no teeth. Europe carries off the palm for the oldest fossil birds, the oldest American forms being the Odontornithes, or birds with teeth, lately found in the Kansas chalk.

The Tertiary of Western America comprises the most extensive series of fossil vertebrates known to geologists and it was here that the oldest representative of the horse, the diminutive Eohippus, was discovered and made by Huxley to assume the apex of the evolution pyramid, the crowning glory of the theory.

The most remarkable of the Mammals yet found in America are the *Tillodontia*, which are claimed to combine the characters of several different groups, viz: the Carnivora, the Ungulata, and the Rodents.

It is a singular and notable fact that no traces of any Anthropoid Apes or of any Old World monkeys have yet been detected in America. Man, however, who doubtless crossed into America by way of Behring's Straits, and at his advent became part of our fauna as a mammal and a primate, has left his bones and works from the Arctic Circle to Patagonia, principally, however, in the Post Tertiary, though there is evidence that he existed in the Pliocene.

Regarding the position of man on the earth and among the other members of the Primate group, the Professor says, "the oldest known remains of man on this continent differ in no important characters from the bones of the typical Indian, although in minor details they indicate a much more primitive race. These early remains, some of which are true fossils, resemble much more closely the corresponding parts of the highest Old World apes, than do the latter our Tertiary Primates, or even the recent American monkeys. Various living and fossil forms of Old World Primates fill up essentially the latter gap. The lesser gap between the primitive Man of America and the Anthropoid Apes is partially closed by still lower forms of men, and doubtless also by higher Apes now extinct. Analogy, and many facts as well, indicate that this gap was smaller in the past. It is certainly becoming wider now with every generation, for the lowest races of men will soon become extinct, like the Tasmanians, and the highest Apes cannot long survive."

In closing the article he speaks as follows: "If the history of American mammals, as I have briefly sketched it, seems, as a whole incomplete and unsatisfactory, we must remember that the geological tree of this class has its trunk and larger limbs concealed beneath the *debris* of Mesozoic time, while its roots doubtless strike so deeply into the Palæozoic that for the present they are lost. A decade or two hence, we shall probably know something of the mammalian fauna of the Cretaceous, and the earlier lineage of the existing mammals can then be traced with more certainty."

The objection to this address as "history" is that the facts stated by Professor Marsh are all selected with express reference to and in support of the text that "Evolution is Science and Science is truth," and that the facts tending to antagonize the evolution theory are not given equal prominence, as exact history demands that they should be. Not that we would charge so eminent a philosopher and student with unfairness in discussing scientific subjects, but simply take the position that his train of thought, whether in exploring the geological formations of Kansas and Colorado, the archæological remains of California, or in pursuing his investigations among the rare specimens of palæontology in the cabinets of Yale College, has been directed in the channels of evolution and natural selection, and he naturally and consequently fails to do that justice to those facts which rise in strong opposition to his theories which the equities of the case demand from an impartial historian. With this view of the matter, the address seems, perhaps, to have been given too general a title.

The quotations given above show some admissions of weakness in the argument, some missing links in the chain and the inconsequence of the conclusion arrived at, and prove very clearly that while evolution may account for some points in the history of progress on the earth, it requires too much purely theoretical support to be accepted as entirely satisfactory as a whole until it has passed far beyond its present status.—[ED.

EDITORIAL NOTES.

BY AN ERROR in the book bindery a few copies of the October number of the REVIEW were defective. Subscribers having received such copies will be supplied with perfect ones upon notifying the editor.

KANSAS CITY ACADEMY OF SCIENCE.

The academy met at its rooms on the evening of the last Tuesday in October, President Van Horn in the chair.

The exercises of the evening were an article on Cone Sections, by Professor J. M. Greenwood, which we regret not being able to reproduce in the REVIEW from the fact that it requires all the illustrations given by the Professor, by black-board drawings and models, to bring out its numerous interesting and valuable points; and one on the Loss of Heat and Light in the Solar System, by Judge E. P. West, which constitutes the first article in this number.

These meetings of the Academy are extremely interesting to those who attend them but the attendance is rather limited, considering the number of professional men, teachers, students and other intelligent people who make up so great a portion of our population.

On motion, T. S. Case was appointed to read a paper at the next meeting, on the last Tuesday of November. The subject will be "Some of the Objections to the Evolution Theory."

THE very interesting article on "Electrical Conduction," by Prof. R. C. Kedzie, of Lansing, Michigan, noticed in the REVIEW of last has been reprinted in the London *Telegraphic*

Journal. This may be regarded as quite a tribute to its merit, as the *Journal* is one of the best electrical authorities published. Prof. Kedzie is a relative (brother, we believe,) of Prof. W. K. Kedzie, of the Kansas State Agricultural College.

MORRISON OBSERVATORY.—Professor C. W. Pritchett, of the Pritchett School Institute, Glasgow, Mo., announces the opening of this observatory, which has recently been adequately endowed by Miss Morrison, and supplied with the best instrumental outfit for meridian and equatorial work in this portion of the country, and invites the attention of all who desire instruction in spherical and practical astronomy. He also promises an occasional article for publication in the REVIEW, and we expect to make arrangements with him for a series of astronomical notes similar to that furnished the *Scientific American* from Vassar College observatory.

WE are indebted to the *Science Observer*, the *Industrialist*, the Lawrence *Journal*, the Brookfield *Gazette*, the Galena *Miner*, and the *Druggist's Circular*, all of which are excellent papers in their various classes, for complimentary notices since our last issue.

EARTHQUAKE.—A distinct earthquake shock was felt in this city at about twelve o'clock, noon, on the 15th, inst., sufficient to jar buildings perceptibly, but without doing any damage. It was also observed at Omaha, Council Bluffs, St. Joseph, Topeka, Iowa City, Yankton, and other points in the West. At Topeka the motion seemed to be from north to south, while at Council Bluffs it is reported as having been from east to west. Judging from the telegrams received from the above named points, the motion was greatest at Yankton, where it is described as having been the most severe ever experienced in that valley. At Omaha and Council Bluffs it was quite sharp and the destruction of some high buildings was seriously threatened. At Topeka and here a very slight vibration only was observed, which lasted but a few seconds.

NOTICES OF PUBLICATIONS RECEIVED.

NORTH AMERICAN REVIEW, Nov —Dec, 1877; pp 200. J. R Osgood & Co., Boston: $5.00 per annum; single copies, $1.00.

This standard work has for more than 60 years maintained its high position among the most able and scholarly periodicals of the world, and, while perhaps at times rather "heavy" for general readers, it has always borne a high character as an indisputable authority on all topics treated in its pages. Within the past few months a modernizing change has been made in the character of its articles and its editor now aims to "make the *Review* a vehicle for the intellectual forces which are at this moment working in men's minds." How well he has succeeded in this effort is indicated by the table of contents, which is as follows:

Resumption of Specie Payments, by Hugh McCulloch, Judge W. D. Kelley, Gen. Thomas Ewing, David A. Wells, Joseph S. Ropes and Secretary Sherman; Cavalier de la Salle, by Francis Parkman; The War in the East, by Gen. Geo. B. McClellan; The Functions of Unbelief, by Thomas Hitchcock; The Southern Question, by Charles Gayarre, of Louisiana; Michelangelo and the Buonnarroti Archives, by T. Adolphus Trollope; America in Africa, by Gilbert Haven; The Situation in France, by a Paris Resident; How shall the Nation Regain Prosperity? by David A. Wells; The Ultramontane Movement in Canada, by Chas. Lindsey; Contemporary Literature.

This number is published by James R. Osgood & Co., Boston. The *Review* in the future will be published by D. Appleton & Co., New York. For sale by all booksellers.

THE KANSAS COLLEGIATE. A monthly publication devoted to the interests of the State University, Lawrence, Kansas.

This is a monthly Literary and Scientific periodical, conducted by the students of the Kansas State University. Its contributors are frequently the Professors of the University, and the articles published in the last number are of an unusually interesting character, from the fact that they are mainly papers lately read before the Kansas Academy of Science. Price, 50c per college year.

XUM

THE AMERICAN JOURNAL OF SCIENCE AND ARTS, monthly; New Haven, November, 1877; 96 pp. Price, $6.00 per annum; single numbers, 55c.

We gladly add this veteran Scientific Journal to our list of exchanges, it being undoubtedly the most valuable periodical of the kind in the United States and a high authority in Great Britain and on the continent.

Its editors and proprietors are Professors James D. Dana, B. Silliman and E. S. Dana, assisted by Professors Asa Gray, Walcott Gibbs and J. P. Cooke, Jr., of Cambridge; Professors H. A. Newton, S. W. Johnson, G. J. Brush and A. E. Verril, of New Haven, and Prof. Geo. F. Barker, of Philadelphia, a greater array of scientific talent probably than can be found connected with any similar journal in the world. The present number contains articles of marked interest and value by Profs. O. C. Marsh, J. D. Dana, W. Pengelly, Chas. B. Warring, J. W. Mallet and Simon Newcomb; with chapters of Scientific Intelligence on Chemistry and Physics; Geology and Mineralogy; Botany and Zoology; Astronomy and Miscellany, by the proper editors above named respectively and other scientific writers and workers.

POPULAR SCIENCE MONTHLY, November, 1877.

As usual this excellent magazine reaches us promptly, and as usual is filled with carefully written and intensely interesting articles. For the general reading public there is no periodical published which seems to equal it so far as as popular scientific articles are concerned. Among the most interesting and valuable articles in the present number are The Growth of the Steam Engine, by Prof. R. H. Thurston, (illustrated); Modern Troglodytes, by Felix L. Oswald, M. D.; Man and the Glacial Period, by Thos. Belt, F. G. S., (Illustrated); Effects of Study on the Eyesight, by Ward McLean. Price, $5.00 per annum; single number, 50c.

THE JEWELL, November, 1877; Vol. III No. 1; Evans Bros., Liberty, Mo.

This is a collegiate magazine, published by the Professors and students at William Jewell College. It is devoted to general Literature and comes to us after a brief suspension with an attractive and varied table of contents. We wish it a most successful career. Price, $1.50 per annum; single numbers, 15c.

THE NEW YORK MEDICAL JOURNAL; Vol. XXVI, Number 5; pp 112; monthly. D. Appleton & Co.

This long established and popular Medical Journal is edited by James D. Hunter, M. D., who is well known to the medical profession as able and experienced physician and writer.

The present number contains a large number of first class articles, one of which, from the pen of Prof. Austin Flint, Jr., we copy in full, giving as it does the latest and most exhaustive experiments upon and investigation of the causes of the apparent want of breath at times when the lungs are full of air, as well as accounting for various forms of convulsions and perhaps of epilepsy itself. The reports of proceedings of societies, clinical observations and operations are very interesting.

Price per annum, $4.00; single number, 40c.

BINGLEY'S ANIMAL KINGDOM; Hubbard Bros., Philadelphia, 1877.

This popular work is now being delivered in this place, the agent, Mr. L. L. Boynton, having sold quite a large number of copies among our citizens. It is an excellent thing for teachers and heads of families for use in the instruction of children, and is written in so attractive a manner as to be interesting and instructive to the general reader of almost any age.